The price elasticity of demand for parking: a case study of Hoorn, The Netherlands

Master Thesis

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Abstract

Nowadays, parking pricing is a very useful tool for cities in order to have an efficient parking policy. This thesis aims to investigate the effect of tariff changes on parking demand in the city of Hoorn, The Netherlands. Price elasticities are used to analyze the sensitivity of demand in terms of parking duration and the amount of parkers. Internal and external factors are used to explain the results. For the on-street locations, inelastic demand is found both in terms of parking duration and amount of parkers. For the garages, the demand is elastic in terms of parking duration. Contrary to the theory, elasticities larger than zero in terms of the amount of parkers are obtained for the garages. The overall conclusion is that the municipality of Hoorn should not be afraid to raise their tariffs, since the demand for parking is considered to be inelastic in general.

Acknowledgements

This thesis is my independent work and I am responsible for any remaining mistakes. The research is done with data provided by Spark, for which I would like to express my gratitude. I would also like to thank the municipality of Hoorn, for their permission to use the data and Charlotte Bakker for the interesting conversation about their parking policy.

Special thanks go out to Giuliano Mingardo for his great supervision, expertise and help during the process of writing this study. Next, I would like to thank Jan-Jelle Witte for his idea to use elasticities in order to analyze parking in Hoorn, which made the data a lot more workable.

Finally, I would like to express my great appreciation to my parents who have always supported me and my choices during my study, both emotionally and financially.

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List of Tables, Figures and Formulas

Section 1: Introduction

This thesis aims to investigate the price elasticity for parking demand in the city of Hoorn, The Netherlands. This case study is conducted with the support of Spark Parkeren, who provided the data and possibility to set up the research, and of the city of Hoorn that allows the use of the data. Spark Parkeren is a Dutch consultancy company specialized in parking. Spark gives advice and support to a variety of municipalities, airports, hospitals, housing associations, investors, retailers and universities.

In this chapter, the topic of this study will be introduced and arguments for conducting the research will be provided. The scope and research goal will be explained, along with the presentation of the research questions. The chapter ends with the setup for the remainder of the study.

1.1 Problem statement

Almost any car trip needs a parking space. Therefore, parking is the beginning and the end of every trip. For this reason, parking constantly demands valuable space in a city. It is important to maximize its utility, in order to use the space efficiently. Besides, an efficient parking policy also reduces cruising for parking and thereby minimizes pollution. A valuable tool for policy makers to achieve these goals is parking pricing.

The primary objective of setting a price on parking, for parking facility operators, is to cover costs and earn a reasonable return on investment (TRB, 2000). However, this objective must often be balanced against other objectives, such as the desire to attract shoppers, visitors or employees. On the other hand, the primary objective for a local authority is to manage car use and reduce search traffic, in order to prevent congestion and pollution.

Evidence collected by other studies shows, that changing or introducing a parking fee does have an effect on parking decisions. For instance, most Americans can park for free at their work, but 19 to 81 percent fewer employees would drive to work alone when they had to pay for their own parking and between 15 and 38 percent of employees would use another transportation mode (Willson & Shoup, 1990). A study conducted in Israel reports evidence that following from the introduction of a parking fee, 54 percent of the drivers would prefer other option to avoid the charge (Albert & Mahalel, 2006). The last example for the effect of the introduction of a parking fee stems from the Portland Central Business District. Normally, with free parking, 62 percent of commuters drives alone, 16 percent commutes in carpools and 22 percent will travel with transit. A multinomial logit model was used to predict that when a daily parking charge of six dollar is introduced, 46 percent will drive alone, 4 percent will ride in carpools and 50 percent will ride transit (Hess, 2001).

Also intuitively, one can relate that changing tariffs might have an effect on the demand for parking. One way to analyze such changes in demand for parking is by calculating the price elasticity. The price elasticity of demand measures the responsiveness of demand to a change in price, with all other factors held constant (ceteris paribus effect).

Several papers have been written on this topic. The previously mentioned study from Israel reflected high demand elasticities with respect to parking fees with an average of -1.2 (Albert & Mahalel, 2006). Another study from Dublin, regarding on street parking, showed that the elasticity of parking demand can not only vary between different user types, but also between different time periods during the day (Kelly & Clinch, 2006). The same issue was researched for Seattle (USA). Here it was found that on-street parking was price inelastic, but again highly dependent on circumstances (Ottosson, C, Wang, & Lin, 2013). A study regarding Almere (The Netherlands), concluded that the demand for on-street parking is price elastic, but that the price elasticity is much smaller for shorter parking durations (Kobus, Gutiérrez-i-Paigarnau, Rietveld, & Ommeren, 2013).

Besides tariff changes, there are a lot of other factors of which one may consider to have an influence on the demand for parking. For instance, a study conducted in Rotterdam (The Netherlands) indicated that factors like number of households, employment, and number of companies were found to have a significant effect on parking demand (Romaszewski, 2014). Factors like this might be used to explain possible changes in demand for parking.

For Dutch cities and municipalities, parking policy is in the task portfolio of the local government. The problem however is, that actual data about the parking capacity and use of parking is unknown to the people who are responsible for developing effective policies. During my work, I learned that this is also the case for the city of Hoorn. This absence of data raises problems regarding the understanding of the status of a city's parking performance, and relating it to demographic developments.

2.2 Aim and research question

This study distinguishes itself from others by performing an analysis over a considerable time span of 3 to 5 years, for 14 different parking locations, of which two are garages, in one single city: Hoorn. The municipality of Hoorn is small enough to be specific and, in terms of amount of parking spaces, diverse enough to investigate. The primary aim of this research is to investigate whether people who park their cars in Hoorn are sensitive to tariff changes. The next step is to find possible explanations for their (in)elastic behavior.

This has led to the following research questions:

1. *What is the effect of tariff changes on the parking behavior in Hoorn?*
2. *How can changes in parking behavior be explained?*

The remainder of this thesis is composed of four more chapters. This structure can be graphically displayed in the following way:

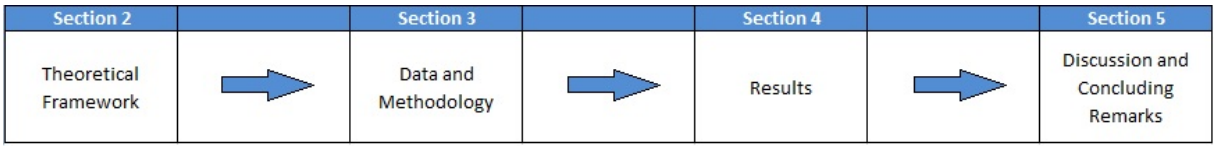


Figure 1: Structure remainder thesis

Section 2 provides a theoretical framework, or literature review, on the main concepts related to this study. It discusses parking pricing and price elasticity and some external explanations for changes in parking behavior.

Section 3 is the section "Data and Methodology" which comprises a description of the municipality of Hoorn, along with its characteristics and a description of the parking locations. Furthermore, the tariff structure will be explained and descriptive statistics on the parking data will be provided. This chapter concludes with an outline of the used methodology and the hypotheses that will be tested during the research.

Section 4 offers an extensive presentation of the results that were obtained from the analysis, supported with explaining tables.

Section 5 discusses the main results, provides conclusions and presents the main achievements obtained from this research. Also, the limitations and shortcomings will be given, along with some ideas for further improvements that can be made when investigating a case with a similar subject.

Section 2: Theoretical Framework

This section will present an overview of the literature that has been written on the matter that will be analyzed during this study. As mentioned in Section 1, three main topics will be considered. The first part will be on parking pricing and policy objectives. Next, there will be a presentation of comparable research on price elasticities of demand for parking. Finally there will be some discussing on factors other than price changes that can affect the demand for parking.

2.1 Parking pricing and policy objectives

The function of parking pricing has been researched for many years. As described in the early 70s, parking prices are an important link between the many people participating in an urban transportation system. These prices directly motivate the automobile driver, the parking lot manager, the landowner and the urban planner. Indirectly they also affect the prosperity of other business activities in the Central Business District as well as the residents of the surrounding community. (Brown & Lambe, 1972)

Early work from the beginning of the 1990's focused on the reduction of traffic jams and congestion (Arnott, de Palma, & Lindsey, 1991) (Glazer & Niskanen, 1992). Arnott et al specified their research to morning rush-hour traffic and found that spatially varied parking fees can significantly reduce travel costs in urban areas. The total travel costs are composed of in-transit travel time, walking time costs, schedule delay costs, tolls, and parking fees. As can be seen, in this model, the search time for parking is neglected. These costs can be minimized by competitively set parking fees, but this does not eliminate congestion, therefore they conclude that the social welfare gains are limited. Glazer and Niskanen made a comparison between parking pricing and road pricing. One of their conclusions is that parking fees substitute tolls when they incur higher trip costs. They also state that this conclusion needs some reservation. For instance, some drivers can vary parking duration and some drivers do not intend to park. In the absence of road pricing, this results in lower parking durations and therefore increasing congestion.

More recent work focuses on both parking fees and congestion tolls. For instance, Verhoef et al (1995) note that parking fees are the "second-best" policy instruments. This is because they cannot be differentiated over trip length or travelled roads. According to their research, time varying parking fees are superior to supply restrictions, mainly because there is temporal inefficiency. By this, they mean the fact that it is not always the parker with the highest willingness to pay that gets the spot; mostly it is first come, first serve. Shiftan and Golani (2005) conducted a survey in Tel Aviv (Israel) on

higher parking costs and the majority of respondents indicated that they would change their travel mode and, in case of congestion tolling, also their travel times. Albert and Mahalel (2006) also performed a survey with respect to parking fees, they came up with a result that 54% of the respondents would try to avoid charges if a parking fee was introduced and 72% would in case of a congestion toll.

In the first decade of this millennium, most research was conducted on the phenomenon of cruising. According to Anderson and de Palma (2004), cruising represents a major source of congestion in urban areas and search for parking slows down traffic. It does so by necessitating traffic lights at cross thoroughfares and by increasing traffic on the main highway because drivers circle to look for a vacant lot. Taking this feature into account introduces an externality that is not internalized by parking lot owners. Therefore in recent years scholars focus on the benefits of an appropriate parking pricing structure. D'Acierno et al (2006) state that parking pricing strategies are important tools for rebalancing the modal split between private car and transit systems in urban areas and that parking pricing strategies should be area-based, imposing different charges on different parking zones, hereby decreasing the amount of searching time. In an earlier paper of his, Shoup (2006) already stated that cruising traffic and administration costs generated from the under-priced parking are to be addressed in case that the optical occupancy is obtained with the supporting of right pricing. Also Arnott and Inci (2006) concluded that given perfect information about parking spaces and optimal pricing, cruising time is close to zero. This is exactly what Pierce and Shoup (2013) investigated, with the experiment of SFpark in San Francisco (USA). They researched the effect of adjusting the parking fees from period to period until the desired occupancy rate was achieved. In the first year of the experiment, 5294 changes were made in the tariffs. In 32% of the cases the prices were increased, in 31% decreased and kept constant in 37%. All decisions were based on economic criteria and data and there was no revenue generation in the main aims. Pierce and Shoup argue that demand determined the parking fees. In response to the price changes, short-time parkers, carpoolers, those who have difficulty walking, and those who attach high value on saving time are expected to park disproportionately in convenient parking spots, while long-term parkers, solo drivers, those who love walking, and those who attach low value on saving time are expected to move towards distant parking spaces. Their conclusion is that the pricing of parking spaces has to be right. Underpriced parking creates large social costs for everyone except a few lucky drivers who happen to find a cheap space. Overpriced parking also causes problems: when curb spaces remain empty, nearby stores lose potential customers, employees lose jobs and governments lose tax revenue.

After the researches on parking pricing and its effects on cruising, some other research has been done on the advantages of parking systems. Edquist et al (2012) presented a research on the effects of an efficient on-street parking system on safety issues in traffic. Although this study is not directly on the effect of pricing, it is related to the topic, since we have seen that pricing is part of an efficient parking structure. The general conclusion of their research is that vehicles parked on-street in a complex, urban environment influenced driver behavior in such a way that they were more likely to crash. Therefore, an efficient parking environment could benefit the safety of other drivers. Sugiarto and Limanoond (2013) investigated the effect of on-street parking on traffic performance in Indonesia. Indonesia suffers from a very rapid increase of motorists in the last few years, resulting in serious congestion problems. They conclude that in order to increase the travel speed and traffic performance, on-street parking should be removed. Also, public services are advised to provide private parking lots in order to release pressure on the streets. As can be seen, also in countries like Indonesia, a good parking system is needed.

This concludes the first section of the literature review. The main conclusion for this part is that parking pricing is a very important and useful tool for policy makers in order to provide an efficient parking system, also in terms of socio-economic benefits. The next section will cover the measurement method for analyzing the effect of a price change, in terms of demand.

2.2 Price elasticity of demand

As mentioned before, a prominent tool in order to analyze the effect of price changes is the price elasticity of demand. According to Pierce and Shoup (2013) the parking price elasticity of demand is a measure of how the price change affects the occupancy rates of parking spots. Or, as Litman (2011) puts it: the percentage change in consumption of parking caused by a one-per cent change in its price. The calculation of the price elasticity of demand for a certain product or service is relatively easy. Sydsaeter and Hammond (2008) present the following method. First, assume that the demand (Q) for a commodity can be described by the following function of price (p):

$$Q = D(p)$$

Formula 1: Demand as a function of price

When the price changes from p to p + Δp, the quantity demanded, Q, also changes. The absolute change in Q is ΔQ, which equals D(p + Δp) – D(p). The relative change is:

$$\frac{\Delta Q}{Q} = \frac{D(p + \Delta p) - D(p)}{\Delta p}$$

Formula 2: Relative change in demand

The ratio between the relative changes in demand and price can be expressed as follows:

$$\frac{\frac{\Delta Q}{Q}}{\frac{\Delta p}{p}} = \frac{p}{D(p)} * \frac{D(p + \Delta p) - D(p)}{\Delta p}$$

Formula 3: Ratio of relative changes in demand and price

This can be rewritten to the price elasticity of a quantity demanded, as a function of price, "ε":

$$\varepsilon = \frac{p}{Q} * \frac{\Delta Q}{\Delta p}$$

Formula 4: The price elasticity of demand

As the most famous law in economics, that of demand, dictates: "the quantity demanded rises, when the price of a product falls, and vice versa". So for most goods, the demand curve is downward sloping (Frank, 2008). Knowing this, one can argue that according to the theory the price elasticity of demand should be negative. For example, when the price of a certain good increases from €5 to €10 and the quantity demanded decreases from 100 to 80, the price elasticity would be:

$$\varepsilon = \frac{10}{80} * \frac{-20}{5} = -0.5$$

The magnitude of elasticity can be interpreted as follows (Parkin, Powell, & Matthews, 2002) and is visualized in Figure 2. If the elasticity equals zero, the demand is perfectly inelastic, meaning that demand does not vary for every given price change. The opposite occurs when the elasticity equals minus infinity, then the demand is perfectly elastic, meaning that if the price of a product drops, its demand rises to infinity.

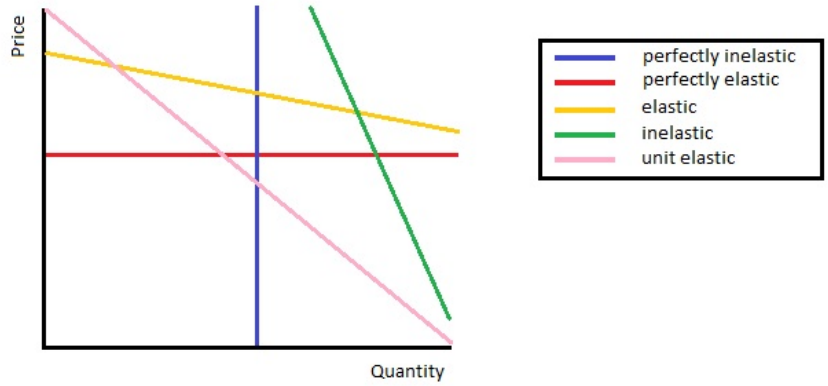


Figure 2: Different types of price elasticity

The more common types of elasticity are the following three.
First there is (relatively) elastic demand. This is when the elasticity lies between minus 1 and minus infinity. Here, the percentage change in quantity is larger than the percentage change in price, resulting in a shallow demand curve, therefore $\varepsilon < -1$.
Secondly there is (relatively) inelastic demand. This is when the elasticity lies between minus 1 and zero. Here, the relative change in quantity is less than the relative change in price, this results in a steeper demand curve, therefore $\varepsilon > -1$.
Finally, there is unit elasticity. Here, the percentage change in quantity demanded is equal to the percentage change in price. Therefore the elasticity in this case equals minus 1, which is also the slope of the demand curve.

In this study, the price elasticity of demand will be used to investigate the sensitivity of people who park in Hoorn to the introduction of a tariff change. There already is quite some research on this topic. Below, an outline of the most important results will be given.

It was already in the late seventies of the previous era that Gillen (1978) used data on the Toronto metropolitan area (Canada) and derived elasticities for changes in prices, walking times and full prices, which is the sum of both. The elasticities for parking fees increased from -0.24 to -0.41 with growing distance (in blocks), whereas the elasticity for walking times decreased from -0.53 to -0.38 over distance. The full price elasticity is practically constant around -0.78.

Kanafani and Lan (1988) studied the price elasticity of parking at San Francisco Airport in the USA. They found a wide range of elasticities varying from -0.3 to -3, with a general tendency that people who parked for 3 hours to 5 days are the most elastic.

Henshes and King (2001) obtained results on the central business district in Sydney (Australia). The elasticities the found are -0.541, -1.015 and -0.476 for parking in the center of the CBD, elsewhere in the CBD and at the border of the CBD respectively. The greatest sensitivity is found for parking elsewhere in the CBD, according to them suggesting that those who choose to park as close as possible to their final destination are relatively less sensitive to parking rates, as are border parkers compared to the other parkers in the CBD.

Hess (2001) investigated the effect of different daily parking costs on the number of cars parked in the central business district of Portland (USA). He obtained different elasticities for different price levels. The elasticities increased with the daily parking costs, ranging from -0.02 for a one dollar ticket to -0.44 for a 5 dollar ticket.

Vaca and Kuzmyak (2005) made an analysis of empirically derived and modeled parking demand elasticities for area-wide parking prices. This resulted in a general range of price elasticities from -0.1 to -0.6. The most frequently presented value is -0.3.

For Dublin (Ireland), Kelly and Clinch (2006) find only small differences between demand for business and non-business trips as a result of small increases in parking prices. However, when the price changes increase, the demand for business trips is much more inelastic than that for non-business trips.

Albert and Mahalel (2006) found an elasticity of -1.2 for the introduction of a parking fee in Tel Aviv (Israel), which is relatively elastic.

Again for Dublin (Ireland), Kelly and Clinch (2009) calculated demand elasticities by making use of a city-wide 50% increase in hourly tariffs. As a result, the average parking duration decreased by 16.5%, implying an increase parking availability. The average price elasticity is -0.29, and it ranges from -0.15 to -0.61, which is inelastic. They also find that the elasticity of parking demand is depending on the moment of the day.

Simicevic et al (2012) reported elasticities varying from -0.34 to -0.50 for the central business district of Belgrade (Serbia). Again, the demand is inelastic.

Kobus et al (2013) investigated the elasticities for Almere (Netherlands) and found that given a parking duration of 60 min, the price elasticity of on-street parking is equal to -5.5, and the price elasticity of the garage parking is equal to -2.2. Their estimations also imply that the elasticity is much smaller for shorter periods. Namely, for a parking duration of 20 minutes the on-street parking elasticity equals -0.9 and -1.5 for garage parking.

Ottoson et al (2013) conducted a case study in Seattle (USA) and made two main conclusions. First of all, the price elasticity of parking is inelastic and varies by time of day and neighborhood characteristics. Their results also showed that pricing affects duration. People park for a shorter time in areas with increased tariffs and longer in those with decreased tariffs.

Pierce and Shoup (2013) conducted a research in San Francisco (USA). Their main conclusions do all have one thing in common: they conclude that elasticity is variable over different factors. The first factor is location, elasticities ranging from -0.53 to -0.21 have been found over different zones. The second factor is daytime and weekday, demand is considered to be less elastic in the morning than in the midday and afternoon and less elastic during the weekend than on weekdays. The third factor is the initial price, the price elasticity for the most inexpensive parking zones is the lowest and elasticity

increases as prices increase (until it reaches a certain plateau, after which it decreases). The fourth factor is the size and direction of the price change. The reaction is strongest, hence the elasticity the largest, with the largest price changes. For equal price changes in both directions, the elasticity is larger for price increases than decreases. The fifth and final factor is time, elasticity varies over time.

Zhang (2014) investigated the elasticity of on-street parking in Stockholm (Sweden). The results show that demand is relatively inelastic. The elasticities range from -0.17 to -0.29 and are different for street type and time of day. Raising the price leads to a reduction in parking duration, this has reduced the congestion.

Hoss (2014) and Romaszewski (2014) both analyzed data on Q-Park garages across the Netherlands. Hoss reports long-run elasticities ranging from -0.31 to -0.37, and short-run elasticities of about three times smaller. Romaszewski found some price elasticities to be significant, but only in a select number of cases, which depended on the day of the week, month, and location of the garage.

This ends the section of the literature review on the price elasticity on the demand. The main conclusion is that the price elasticity for parking demand is very on different factors: location, time, the relative price change and the direction of the price change. Most of the studies have reported inelastic demand for parking, with an average elasticity of -0.3. While this section has focused on the effect of prices on the demand, the next section will cover different (external) factors that can influence the demand for parking.

Next, an overview of the found price elasticities per study is given:

Study	Price Elasticity
Gillen (1978)	-0,78
Kanafani and Lan (1988)	-0,3 to -3
Henshes and King (2001)	-0,47 to -1,02
Hess (2001)	-0,02 to -0,44
Vaca and Kuzmyak (2005)	-0,1 to -0,6
Albert and Mahalel (2006)	-1,20
Kelly and Clinch (2009)	-0,29
Simicevic et al (2012)	-0,34 to -0,50
Kobus et al (2013)	-2,2 to -5,5
Pierce and Shoup (2013)	-0,53 to -0,21
Zhang (2014)	-0,17 to -0,29
Hoss (2014)	-0,31 to -0,37

Table 1: Price elasticities per study

2.3 Other factors

Next to pricing, one can imagine that there are other factors influencing the demand for parking. Nevertheless, there is only a small amount of empirical research on this topic. Below, a brief overview of different factors will be presented.

Besanko et al (2010) state that parking facilities can profit from economies of density, when located in a desirable area. Intuitively one can argue that the desirability of an area can be based on different factors like monumental sights, shops, workplaces and houses. Following the logic of Romaszewski (2014), the amount of monuments, retail, jobs and households may be subject to change as times go by, due to economic fluctuations and city development. This would mean that the desirability of a location is variable over time, which may have an effect on the demand for parking.

The next factor to be discussed is income. Although income is of course directly related to the willingness to pay and therefore the price of parking, it still can have an effect on the price elasticity. Again, following the logic of Romaszewski (2014), a higher income in an area will most likely lead to higher prices in the area. Relatively speaking, if one owns a higher income, share of parking in its income will be lower. This might lead to a decrease in elasticity. Besides, Dargay (2001) argues that higher incomes are positively correlated with the possibility of owning a car. More car ownership means a higher demand for parking. Summarizing, a higher income is expected to lead to a higher demand for parking and a decrease in elasticity.

As can be seen, there are some external factors that need to be considered when analyzing the demand for parking in a city. The factors mentioned in this section will be used to explain the results that occur in the results of Section 4. The location desirability will be expressed in terms of tourism, jobs, retail, housing and number of inhabitants. The income will be expressed in the terms of average income per head.

The next section will be on the data and methodology used for the analysis.

Section 3: Data and Methodology

3.1 Data

In this section, the data used for this study will be discussed. Also, an outline will be given about the municipality of Hoorn and the characteristics of the parking locations.

3.1.1 The municipality of Hoorn

The dataset for this study was obtained from Spark Parkeren (2015). This dataset covers daily transaction data on two garages and twelve on-street parking locations in the municipality of Hoorn. Hoorn is a small city located in the Netherlands in the province North-Holland, with 71.000 (Hoorn, 2015) inhabitants (see Figure 3). The area in which Hoorn is located is called “West-Friesland” by the inhabitants itself.

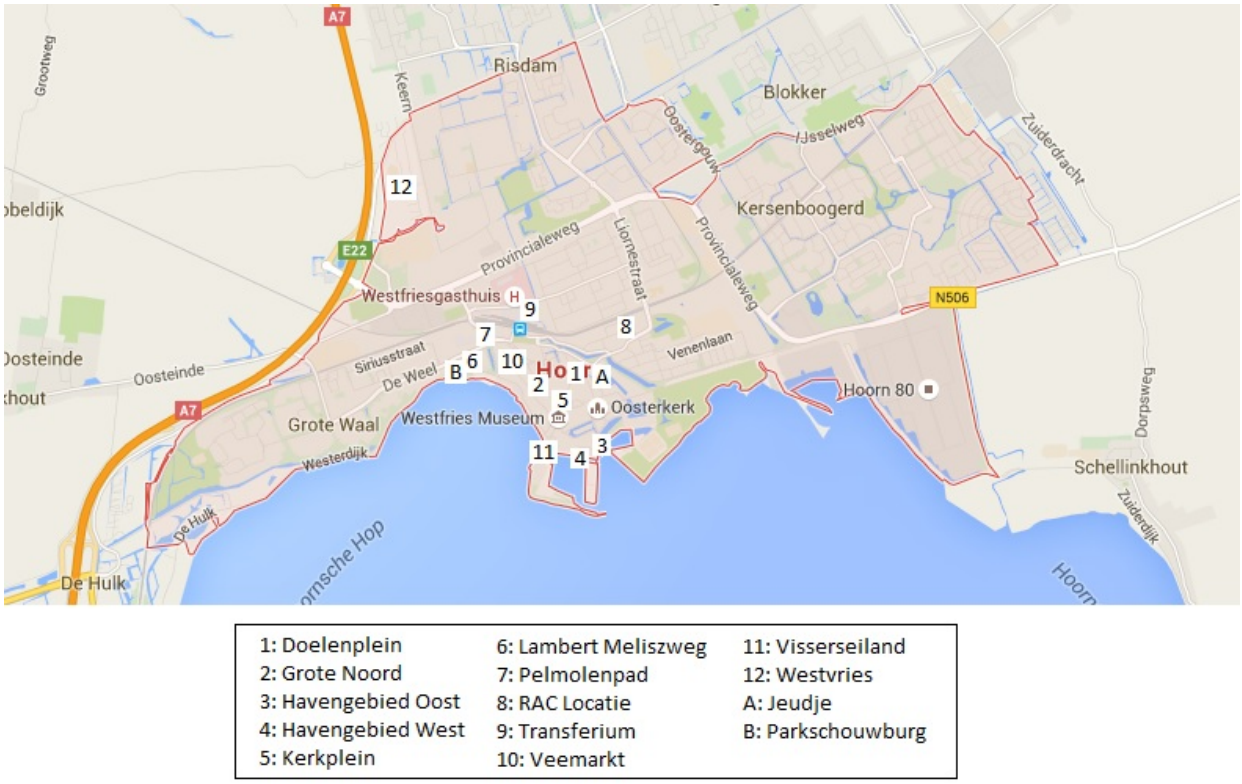
Figure 3: Location of Hoorn in the Netherlands

In terms of location, Hoorn has a direct rail connection to Amsterdam and Schiphol Airport and connections to the Randstad area. On the shore of the IJsselmeer, Hoorn has great attractive power to people for spending their leisure time. Hoorn also has a rich past, because in the Golden Age Hoorn was one of the bases of the VOC and a powerful trading town. The inherited prosperity can still be found in the historical centre. After Amsterdam and Haarlem, Hoorn is the third monumental city in North-Holland.

According to research by NTBC/NIPO, the foremost reason to visit Hoorn is recreational shopping (53%), 8% of the visitors came to eat, or sit on a terrace, 4% came for a recreational walk and 8% to visit a museum (CVO, 2014).

3.1.2 Locations of On-street locations and Garages

As mentioned before, data is available on twelve on-street locations and two garages. These locations and garages are unequally distributed over the municipality, as can be seen on the map in Figure 4. In collaboration with a policy officer on parking of the municipal board of Hoorn, the following characteristics of the locations were formulated.



1: Doelenplein	6: Lambert Meliszweg	11: Visserseiland
2: Grote Noord	7: Pelmolenpad	12: Westvries
3: Havengebied Oost	8: RAC Locatie	A: Jeudje
4: Havengebied West	9: Transferium	B: Parkschouwburg
5: Kerkplein	10: Veemarkt	

Figure 4: Geographical distribution of parking locations

There are several parking locations situated in the city centre, most of the people that park here are people from surrounding towns and villages, who come to shop. The concerned locations are Doelenplein, Grote Noord, Kerkplein, Veemarkt and the Jeudje garage. Next, there are two locations near the harbor, Haven Oost and Haven West. Most people who park their cars here come as tourists, or to dine at one of the restaurants near the harbor. There are also three possible parking options on the outside of the centre: Lambert Meliszweg, RAC Locatie and Visserseiland. The first one is used is the locations in the centre are too crowded or full, so most people who park here are also coming to shop. The second one is less well-known as other locations, it is a location which is mostly visited by people who know Hoorn, so either inhabitants or regular visitors. Visserseiland is mostly used by tourists, who want to visit museums or the harbor, but do not want to pay the highest tariff. The two parking locations on the outer ring of the centre, located near the station are Pelmolenpad and Transferium. The first one is used by people who want to visit Hoorn for a whole day, so mostly

tourists. The second one is used by commuters, who park their cars and travel along with the train to their work. The last on-street location that needs to be discussed is the Westvries, which is located near an ice skating facility. This location is not used by parkers with other means than visiting the ice hall. Most of the visits to this parking location are in the winter season, so from September to March. Finally, there is the Parkschouwburg garage, which is located near the theatre. This garage is mostly visited by people who visit a show, but also by people who attend business congresses, because these take place in the theatre.

3.1.3 Tariffs

The municipality of Hoorn applies different tariffs for parking throughout the city. There are six different tariffs for on-street locations. In garages, there is only one tariff. People who park on-street in Hoorn pay Mondays to Saturdays from 9.00 to 18.00 and on Thursdays to 21.00, because the shops are then open in the evening. Every last Sunday of the month, the shops are also open, and parking is paid from 12.00 to 17.00. For the Jeudje garage, the same payment structure applies, except for the fact that payment starts at 12.00 instead of 9.00. For the Parkschouwburg the payment structure is different, because most shows are in the evening. Therefore, parking is paid from 12.00 to 01.00 for every day, so also Sundays.

In Table 1 and 2, the tariffs that are paid in the different areas of Hoorn are displayed. As can be observed, a price change for all tariffs in 2012 was made. This allows us to calculate elasticities, which we will discuss later on. Furthermore, it can be seen that there is a gradation in the tariff structure. Tariff A is the highest tariff, which is paid in the city centre. Parking in these areas has a time limit of two hours.

Area	Tariff
Doelenplein	A
Grote Noord en omstreken	A, C
Havengebied Oost	B
Havengebied West	B
Kerkplein en omstreken	A
Lambert Meliszweg	C
Pelmolenpad	D
RAC locatie	E
Transferium	D
Veemarkt en omstreken	A, C
Visserseiland	E
Westvries	F

Table 3: Tariff structure per area

Tariff	2010-2011	2012-2014
A	1,90	2,10
B	1,30	1,40
C	0,50 / 2,10 (day)	0,60 / 2,30 (day)
D	2,10 (day)	2,30 (day)
E	0,50 / 2,10 (day)	0,60 / 2,30 (day)
F	1,00 (day)	1,20 (day)

Table 2: Price paid per tariff over the years

Tariff B is a little less expensive and is paid in the harbor area only and has also a time limit of two hours. In the areas more distant from the city centre and the harbor, the tariff is lower. The tariffs C and E are equal in price and become cheaper if the parking time is longer. It has a maximum daily tariff which is equal to five hours of parking, so every minute longer is free. The tariffs D and F are both inexpensive daily tariffs. One can relate that parking at the Transferium is at a low tariff, because it would be wrong to discourage people from taking the train to work. The same holds for the Westvries ice skating facility, because it is far away from the city centre and used solely by visitors of the ice hall.

In Table 3, the tariff that is paid in both the garages is displayed. As can be seen, the tariff is the same for both garages, only the paid parking hours are different, as mentioned before. Here, there was the event of a price change in 2013, which we can use later on for our calculations.

Garage	2012	2013 -2014
Jeudje	49 min / €	48 min / €
Parkschouwburg	49 min / €	48 min / €

Table 4: Parking tariff garages

Parking in the Jeudje garage can be considered as relatively inexpensive, when compared to the on-street parking locations. For instance, it is close to Doelenplein (tariff A), which is about twice as expensive. On the other hand, the Parkschouwburg garage is more expensive than the nearby located Lambert Meliszweg, which pays tariff C.

3.1.4 Data availability and descriptive statistics

For the garages, the time span is 2012-2014 (3 years) and for the on-street locations the time span is 2010-2014 (5 years). The availability of the data is different for each location or garage, therefore the dataset is unbalanced, but there are enough data points to analyze. In Figure X and Y, the distribution of available days per parking location over time is visualized. As can be seen in Figure 5, most of the on-street parking locations are recorded for over 340 days per year, which is more 93% of the days. There are some fluctuations over time for the top-recorded locations, but these are not expected to lead to a bias. The amount of day entries for Visserseiland increases over time, so despite the fact that it has fewer observations than the majority in the beginning, it almost has the most in 2014. RAC Locatie and Westvries have fewer observed days than the average, but with ranges of 310-335 and 293-304 days respectively, still 88% and 82% of the total days are covered on average.

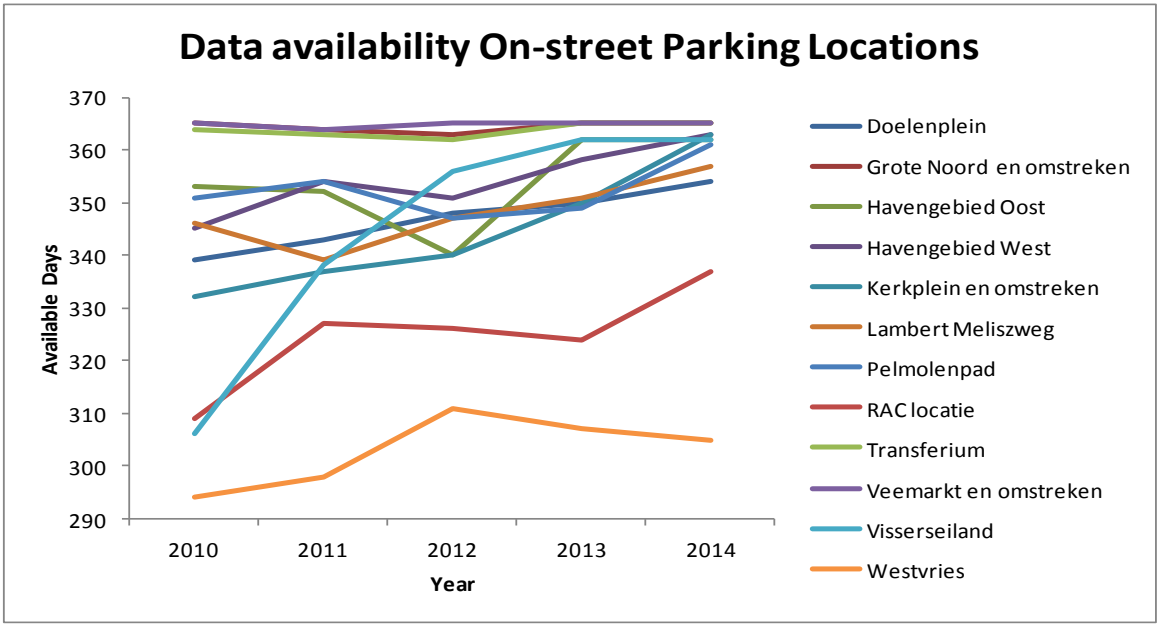


Figure 5: Data availability On-street Parking Locations

What can be observed from Figure 6, is that the datasets for the garages are almost complete in terms of daily coverage. With 2012 being a leap year, 366 days was the maximum possible amount of days that could be observed. For the other two years, this maximum was 365 days. Jeudje has zero missing days over the whole dataset and Parkschouwburg two days. This means that 99.9 percent of all days in the years 2012-2014 have full data for the garages.

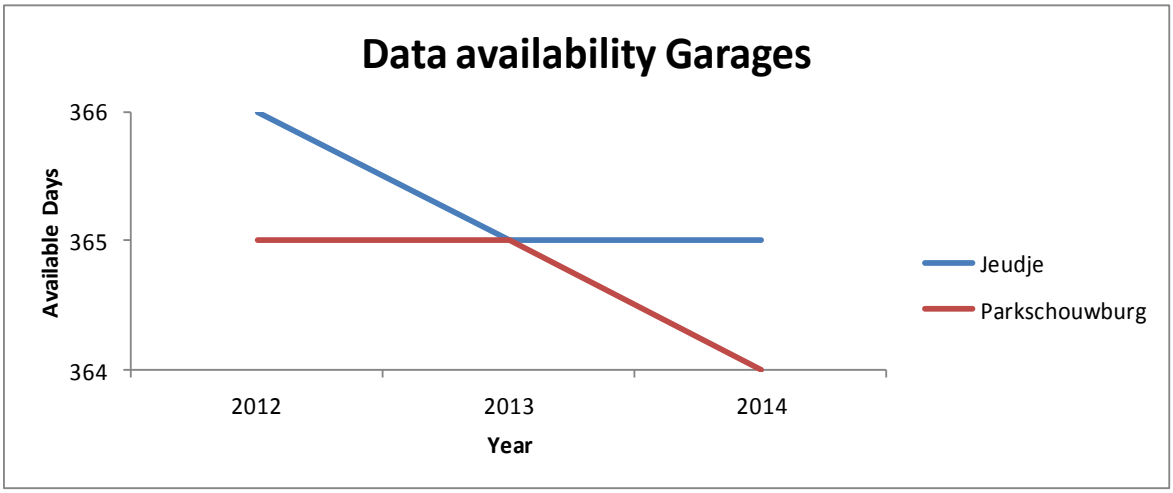


Figure 6: Data availability Garages

The data that will be used throughout the analysis is based on two main determinants. The first one is the amount of parkers per day. This determinant is a clear index of how much demand there is for parking in Hoorn per day, per area or garage. The second determinant is the parking duration of an

individual transaction. This indicator tells us about the amount of parking time that is demanded for the different locations.

Table 4 and 5 represent the average values of the amount of parkers and the parking duration for the on-street parking facilities. As can be observed from Table 4, Veemarkt is the most visited on-street parking location with approximately 43% of the total amount of parkers. Haven West and Visserseiland represent the lowest shares of parkers, with approximately 0.7% and 0.8% of the total. For most of the on-street locations, the amount of parkers is quite constant over time or represented a slight decrease. The only real exceptions are Lambert Meliszweg, RAC Locatie and Westvries with decreases of 33.7%, 24.5% and 23.7% respectively, from 2010 to 2014 and Haven West with an increase of 22.7%.

	Parkers (amount)				
Area	2010	2011	2012	2013	2014
Doelenplein	137	140	131	121	117
Grote Noord en omstreken	465	467	457	439	424
Havengebied Oost	52	37	39	47	51
Havengebied West	22	28	24	30	27
Kerkplein en omstreken	207	226	208	212	198
Lambert Meliszweg	86	84	67	61	57
Pelmolenpad	280	262	247	187	214
RAC locatie	51	58	53	32	37
Transferium	648	667	605	626	649
Veemarkt en omstreken	1.681	1.710	1.532	1.566	1.624
Visserseiland	30	33	30	32	29
Westvries	207	201	182	157	158
Total	3.866	3.913	3.576	3.510	3.585

Table 5: Amount of parkers per On-street Parking Location

As can be observed from Table 5, Transferium and Pelmolenpad have no data available. This is because there is no time registration at those facilities. The on-street parking location with the longest parking duration is Westfries. It accounts for approximately 30% of the total parking time. Doelenplein and Kerkplein represent the lowest parking times, with less than an hour. For most of the on-street locations, the parking time has decreased over time. RAC Locatie and Westfries faced the largest declines in average parking time per individual transaction.

	Duration (hours)				
Area	2010	2011	2012	2013	2014
Doelenplein	0,93	0,94	0,95	0,92	0,89
Grote Noord en omstreken	1,50	1,51	1,40	1,41	1,43
Havengebied Oost	1,23	1,25	1,20	1,17	1,20
Havengebied West	1,26	1,28	1,17	1,19	1,20
Kerkplein en omstreken	0,99	0,97	0,90	0,88	0,90
Lambert Meliszweg	1,78	1,80	1,78	1,79	1,83
Pelmolenpad	*data is not available*				
RAC locatie	5,49	5,28	4,85	4,17	4,06
Transferium	*data is not available*				
Veemarkt en omstreken	1,20	1,21	1,12	1,09	1,10
Visserseiland	4,72	4,82	4,27	3,92	3,70
Westvries	8,40	8,48	8,18	7,69	6,74
On-street locations combined	4,91	4,94	4,80	4,52	4,32

Table 6: Parking duration per On-street Parking Location

Table 6 and 7 represent the average values of the amount of parkers and the parking duration for the garages. As can be observed from Table 6, Jeudje is the most visited garage with approximately 71% of the total amount of parkers. For Jeudje, the amount of parkers has increased over time with 3.7% from 2012 to 2014. Parkschouwburg has a decreasing amount of parkers over time, but had a peak value of 170 parkers in 2013. The total amount of parkers in garages has increased over time.

	Parkers (amount)		
Area	2012	2013	2014
Jeudje	401	410	416
Parkschouwburg	158	170	154
Garages combined	559	581	569

Table 7: Amount of parkers per garage

As can be observed from Table 7, Jeudje is the garage in which people park the longest time, with approximately 2 hours and 37 minutes per transaction. For both Jeudje and Parkschouwburg, the parking duration has increased over time. Jeudje faced a decline of 5.9% from 2012 to 2014 and Parkschouwburg 38.2%. Also, the average parking duration for the total of both garages has decreased. This total decreased with 12.5%.

	Duration (hours)		
Area	2012	2013	2014
Jeudje	2,69	2,65	2,53
Parkschouwburg	2,54	2,56	1,57
Garages combined	2,55	2,59	2,23

Table 8: Parking duration per garage

For comparison, a split-up has been made for the averages of each day. This is done for both the parking duration and the amount of parkers. The results for the on-street parking locations are displayed in Table 8 and 9.

	Parkers (amount)				
Day	2010	2011	2012	2013	2014
Monday	2.886	2.885	2.718	2.722	2.852
Tuesday	3.793	3.855	3.499	3.234	3.648
Wednesday	4.152	4.185	3.810	3.674	3.694
Thursday	5.378	5.357	4.934	4.694	4.822
Friday	4.154	4.397	3.889	4.009	3.995
Saturday	5.099	5.126	4.787	4.885	4.783
Sunday	885	883	832	979	1033

Table 9: Daily split-up amount of parkers for On-street Parking Locations

As can be observed from Table 8, Thursdays and Saturdays are the days with the highest amount of parkers. Sunday is the day with the lowest amount of parkers. It is also visible that the amount of parkers has decreased over time, except for Sundays. As can be observed from Table 9, Sunday is the day with the highest average parking duration per individual transaction, all other weekdays are comparable to each other with averages between 4 and 5 hours. Also, the average parking duration per day seems to be decreasing over time.

	Duration (hours)				
Day	2010	2011	2012	2013	2014
Monday	4,82	5,05	4,82	4,60	4,39
Tuesday	4,35	4,33	4,39	4,14	4,05
Wednesday	4,35	4,35	4,38	4,19	3,98
Thursday	4,09	4,28	4,08	3,96	3,84
Friday	4,02	3,61	4,15	3,77	3,86
Saturday	4,68	4,54	4,34	4,03	4,06
Sunday	8,09	8,00	7,41	6,93	6,08

Table 10: Daily split-up parking duration for total On-street Parking Locations

The results for the daily split-up of the garages are displayed in Table 10 and 11. As can be observed from Table 10, Saturdays are the days with the highest amount of parkers. Sundays and Monday are the days with the lowest number of visitors. As opposed to the on-street locations, Thursdays account for relatively smaller share of the total parking amount and are comparable to Wednesdays and Fridays.

	Parkers (amount)		
Day	2012	2013	2014
Monday	335	352	341
Tuesday	481	517	502
Wednesday	585	618	623
Thursday	674	662	653
Friday	630	644	617
Saturday	993	1.024	989
Sunday	224	248	256

Table 11: split-up amount of parkers for garages

As can be observed from Table 11, Sundays are again the days with the longest average parking duration. All other weekdays are comparable with averages between 2 and 3 hours.

	Duration (hours)		
Day	2012	2013	2014
Monday	2,71	2,56	2,14
Tuesday	2,43	2,48	2,06
Wednesday	2,31	2,44	2,10
Thursday	2,30	2,40	2,06
Friday	2,46	2,55	2,30
Saturday	2,26	2,27	2,13
Sunday	3,39	3,34	2,81

Table 12: Daily split-up parking duration for total garages

From the above mentioned figures, we can conclude that the on-street locations attract more parkers than the garages, in total, and that people also tend to stay longer in an on-street parking location, on average. Sundays seem to be the days in which people park for the longest period of time. Furthermore, the total amount of parkers has decreased in the streets, but increased in the garages. The average parking duration of an individual transaction has decreased over time for both types of locations.

3.2 Methodology

In this section, the methodology used for this study will be discussed. Also, the hypotheses will be presented and explained.

3.2.1 Data preparation

In order for the data to be workable, some preparation has been done. First of all, the weekdays were linked to the date entries in Microsoft Excel. By doing this, the option to compare different weekdays was created.

Furthermore, in order for the parking duration to be used in the analysis, it was needed to convert it into the average individual transaction duration. This was done, because it gives more insight to look at individual parking transactions than at a total. The following formula was used to extract the individual transaction averages out of the raw data:

$$average\ individual\ transaction\ duration = \frac{total\ transaction\ duration}{total\ amount\ of\ transactions}$$

Formula 5: Average individual transaction duration

This calculation was executed for every day, resulting in the average individual parking transaction for each individual day.

3.2.2 Total tariff

As mentioned before, the municipality of Hoorn applies different tariffs for parking throughout the city. There are six different tariffs for on-street locations and one for the garages. In Table 1 and 3, the tariffs that are paid in the different areas of Hoorn were displayed, with the price change in 2012. In order to make calculations about the amount of parkers and the individual parking durations for the totality of on-street locations and garages, an overarching tariff has to be constructed. For the garages, this is easy, because there is one and the same tariff for both garages. Therefore, the total tariff for the garages is displayed in Table 12.

Garage	2012	2013 - 2014
Total	49 min / €	48 min / €
Total	€ 1,22	€ 1,25

Table 13: Overarching tariff garages

For the on-street locations it is not that straightforward, since there are tariffs with daily and hourly rates. Therefore, two types of tariffs for the total were constructed. One based on hourly tariffs, and one based on daily tariffs. The tariff based on hourly tariffs was calculated as follows:

$$hourly\ tariff = \frac{3 * tariff\ A + 2 * tariff\ B + 4 * tariff\ C + 2 * \frac{tariff\ D}{24} + 1 * \frac{tariff\ F}{24}}{12}$$

Formula 6: Hourly tariff

As can be seen, this is a weighted average of the individual hourly tariffs. Tariff A is paid in 3 areas, tariff B in two areas, etcetera. Tariff D and F are divided by 24, in order to convert them into hourly tariffs, because those are solely daily tariffs and the maximum parking time on one ticket is 24 hours.

The tariff based on daily tariffs was calculated as follows:

$$"daily"\ tariff = \frac{3 * tariff\ A + 2 * tariff\ B + 4 * \frac{tariff\ C}{24} + 2 * \frac{tariff\ D}{24} + 1 * \frac{tariff\ F}{24}}{12}$$

Formula 7: "Daily" tariff

As can be seen, this is again a weighted average of the individual hourly tariffs, but next to tariff D and F, the daily tariff of tariff C is now also converted into an hourly tariff. So the daily tariff is still in terms of euro per hour. The total tariff structure is displayed in Table 13:

Total Tariff	2010 - 2011	2012 - 2014
Hourly-based	€ 0,88	€ 0,98
Daily-based	€ 0,74	€ 0,81

Table 14: Overarching tariff on-street locations

As can be seen, the daily-based tariff is lower than the hourly-based one. This makes sense, since the only difference between both tariffs is in the share of tariff C, which has a relatively inexpensive daily tariff. The hourly based tariff increased with 11.4% and the daily based tariff with 9.4%.

3.2.3 Elasticity calculations

In order to answer the research question, the price elasticity of demand for parking spaces in Hoorn has to be investigated. This is done by calculations on two different aspects. The first one is the average duration of an individual parking transaction per location, from now on this will be called "ADIT", for simplicity reasons. The second one is the average daily amount of parkers per location, from now on "ADAP". By using these two indicators, the individual and the total transaction aspects of parking in Hoorn are both covered. This gives a better overview than investigating only one of both dimensions. Microsoft Excel is used to perform all calculations.

For the garages, the comparison between years will be 2012 versus 2013-2014, because the price change was at the beginning of 2013. For the on-street parking locations it will be 2010-2011 versus 2012-2014, because the tariffs were changed in 2012.

The analysis will start with calculations on the garages, beginning with the ADIT. In order to be able to calculate the price elasticity, the average duration of an individual transaction for 2012 and 2013-2014 needs to be calculated. After this has been done, the following formula is applied in order to calculate the elasticity (p.t.o.):

$$price\ elasticity\ of\ demand = \frac{Price_{13-14}}{ADIT_{13-14}} * \frac{ADIT_{13-14} - ADIT_{12}}{Price_{13-14} - Price_{12}}$$

Formula 8: Price elasticity of demand for ADIT (garages)

This formula gives a number, which stands for the price elasticity of demand in terms of the average duration of individual transactions.

Next, the elasticity of demand in terms of ADAP will be calculated. In order to be able to calculate the price elasticity, the average amount of parkers for 2012 and 2013-2014 needs to be calculated. After this has been done, the following formula is applied in order to calculate the elasticity:

$$price\ elasticity\ of\ demand = \frac{Price_{13-14}}{ADAP_{13-14}} * \frac{ADAP_{13-14} - ADAP_{12}}{Price_{13-14} - Price_{12}}$$

Formula 9: Price elasticity of demand for ADAP (garages)

This formula gives a number, which stands for the price elasticity of demand in terms of the average daily amount of parkers per location. Both above mentioned formulas are applied on the Jeudje and Parkschouwburg garages separately, and on the total. Also, the formula is applied to each weekday individually, resulting in elasticities per day.

After the calculations on the garages, the on-street locations will be analyzed, also beginning with the ADIT. Again, the average duration of an individual transaction needs to be calculated, but this time for 2010-2011 and 2012-2014. After this has been done, the following formula is applied in order to calculate the elasticity:

$$price\ elasticity\ of\ demand = \frac{Price_{12-14}}{ADIT_{12-14}} * \frac{ADIT_{12-14} - ADIT_{10-11}}{Price_{12-14} - Price_{10-11}}$$

Formula 10: Price elasticity of demand for ADIT (on-street)

Next, the elasticity of demand in terms of ADAP will be calculated. In order to be able to calculate the price elasticity, the average amount of parkers for 2010-2011 and 2012-2014 needs to be calculated. After this has been done, the following formula is applied in order to calculate the elasticity:

$$price\ elasticity\ of\ demand = \frac{Price_{12-14}}{ADAP_{12-14}} * \frac{ADAP_{12-14} - ADAP_{10-11}}{Price_{12-14} - Price_{10-11}}$$

Formula 11: Price elasticity of demand for ADAP (on-street)

Both above mentioned formulas are applied on all individual on-street parking locations separately, and on the total. Again, the formula is applied to each weekday individually, resulting in elasticities per day.

The results of the above mentioned calculation method will be discussed in the next section. It will be tried to explain the most notable outcomes.

3.2.4 Hypotheses

The above mentioned methodology will test two hypotheses:

1. H_o: When the price increases, the average duration of an individual parking transaction will decrease
2. H_o: When the price increases, the average amount of daily parkers will decrease

Section 4: Results and Discussion

In this section, the results of the above mentioned calculation methods (Section 3.2.3) will be presented. At first, an outline of the calculated results will be given for both garages and on-street areas. In the next section, the most important outcomes will be discussed and some possible explanations will be given. Please note that these are all ceteris paribus effects. Hereby meaning that we indicate the effect of the tariff change, and assuming all other variables that may affect the demand for parking, constant.

4.1 Elasticities for Garages in terms of parking duration

As mentioned before, we have data on two parking garages in Hoorn: Jeudje and Schouwburg. First, the results for the separate garages will be shown. Next, the elasticity of the combined parking supply of garages in Hoorn will be presented. All tables are constructed in the same way, the first row represents the average parking time of an individual transaction in 2012 and the second row contains these values for the years 2013 and 2014 combined.

4.1.1 Jeudje

The calculated results for the Jeudje garage are displayed in Table 14. As can be observed, the average parking time for 2013 and 2014 was shorter than in 2012. In 2012 parkers used the garage for 2.67 hours on average, which equals 2 hours and 40 minutes. In 2013 and 2014 the parking time had an average of 2.60 hours, which equals 2 hours and 36 minutes. From these results, we can conclude that the average parking time decreased by approximately 4.2 minutes for every individual transaction (a 2.6% decrease with respect to 2012). When we look at the tariff change, the tariff increased by 2.5%, from €1.22 to €1.25 per hour. Since the decrease in demand is slightly larger than the increase in price, the demand for parking space in the Jeudje garage is considered to be relatively elastic, which can also be seen in the table. The price elasticity for the total years of 2013 and 2014 with respect to 2012 equals -1.26.

JEUDJE	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2012	2,67	2,52	2,40	2,33	2,27	2,52	2,36	4,24
Avg. parking time 2013, 2014	2,60	2,37	2,36	2,36	2,33	2,53	2,33	3,93
Parking Tariff 2012	1,22	1,22	1,22	1,22	1,22	1,22	1,22	1,22
Parking Tariff 2013, 2014	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25
Elasticity	-1,26	-3,21	-0,89	0,74	1,20	0,18	-0,64	-3,85
Elasticity (absolute)	1,26	3,21	0,89	0,74	1,20	0,18	0,64	3,85

Table 15: Elasticity for Jeudje garage

Now we have the price elasticity of the years in totality, we can also investigate the elasticities for separate weekdays. For instance, a Monday in 2013/2014 compared to a Monday in 2012. Looking at Table 14 for the individual days, we observe that the elasticities are quite different for each day.

What immediately catches the eye is that the elasticities for Mondays and Sundays are way larger (almost 3 times) than for the other days. As can be derived from the results, the average parking time for Mondays and Sundays decreased with 9 and 18.6 minutes respectively. This is a considerable decline and deserves more attention. We will try to explain this in Section 5.1.
For Wednesdays, Thursdays and Fridays the elasticity is larger than zero. This is due to the fact that the average parking time in 2013 and 2014 was longer than in 2012, even though the tariff was higher in these years. Thursdays (+3.6 minute), Wednesday's (+1.8 minute) and Friday's (+0.6 minute) show a positive relationship between price and demand, contrary to what one expects from the theory, which is a lower demand leading from a higher price.
On Tuesdays (-2.4 minute) and Saturdays (-1.8 minute) the demand for parking is quite inelastic, but the numbers are negative, as opposed to Wednesdays, Thursdays and Fridays. This means that the percentage decrease in demand is smaller than the percentage increase in tariff.
Overall, we can conclude that there are the demand for parking (time) in the Jeudje garage is elastic, but this is mainly due to the outcome of Mondays and Sundays.

4.1.2 Schouwburg

The calculated results for the Schouwburg garage are displayed in Table 15. The table is structured in the same way as Table 1. As can be observed, the average parking time for 2013 and 2014 was shorter than in 2012. In 2012 parkers used the garage for 2.54 hours on average, which equals 2 hours and 32 minutes. In 2013 and 2014 the parking time had an average of 2.07 hours, which equals 2 hours and 4 minutes. From these results, we can conclude that the average parking time decreased by approximately 28.2 minutes for every individual transaction (an 18.5% decrease with respect to 2012). The parking tariff increased by 2.5%, from €1.22 to €1.25 per hour. Since the decrease in demand is way larger than the increase in price, the demand for parking space in the Schouwburg garage is considered to be elastic, which can also be seen in the table. The price elasticity for the total years of 2013 and 2014 with respect to 2012 equals -11.36.

SCHOUWBURG	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2012	2,54	3,12	2,65	2,49	2,45	2,39	2,05	3,11
Avg. parking time 2013, 2014	2,07	2,25	2,07	1,99	2,05	2,22	1,91	1,97
Parking Tariff 2012	1,22	1,22	1,22	1,22	1,22	1,22	1,22	1,22
Parking Tariff 2013, 2014	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25
Elasticity	-11,36	-18,86	-13,89	-12,39	-9,59	-3,69	-3,50	-28,27
Elasticity (absolute)	11,36	18,86	13,89	12,39	9,59	3,69	3,50	28,27

Table 16: Elasticity for Schouwburg garage

Again, we can also investigate the elasticities for separate weekdays. Looking at Table 15 for the individual days, we observe that the elasticities magnitude is quite different for each day.

What immediately catches the eye is that the elasticities for Mondays and Sundays are again larger than for the other days. As can be derived from the results, the average parking time for Mondays and Sundays decreased with 52.2 and 68.4 minutes respectively. As mentioned before, we will try to explain this decline in Section 5.1.

For Tuesday, Wednesdays, Thursdays and Fridays the elasticity is comparable to the total elasticity. The average parking time declined with 34.8, 30 and 24 minutes respectively.

On Fridays (-10.2 minute) and Saturdays (-8.4 minute) the demand for parking is less elastic. This means that the percentage decrease in demand is smaller than for the other days.

Overall, we can conclude that there are really large changes in parking time, with a little moderation for Fridays and Saturdays, in comparison with the other weekdays. With respect to the Jeudje garage, the elasticities are bigger. We therefore need to find an explanation for this phenomenon.

4.1.3 Garages combined

The calculated results for the garages combined are displayed in Table 16. As can be observed, the average parking time for 2013 and 2014 was shorter than in 2012. In 2012 parkers used the garage for 2.55 hours on average, which equals 2 hours and 33 minutes. In 2013 and 2014 the parking time had an average of 2.41 hours, which equals 2 hours and 25 minutes. From these results, we can conclude that the average parking time decreased by approximately 8.4 minutes for every individual transaction (a 5.5% decrease with respect to 2012). The tariff increased by 2.5%, from €1.22 to €1.25 per hour, since the tariff is equal for both garages. The decrease in demand is slightly larger than the increase in price, therefore demand for parking space in the garages is considered to be relatively elastic, which can also be seen in the table. The price elasticity for the total years of 2013 and 2014 with respect to 2012 equals -2.96.

COMBINED	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2012	2,55	2,71	2,43	2,31	2,30	2,46	2,26	3,39
Avg. parking time 2013, 2014	2,41	2,35	2,27	2,27	2,23	2,42	2,20	3,12
Parking Tariff 2012	1,22	1,22	1,22	1,22	1,22	1,22	1,22	1,22
Parking Tariff 2013, 2014	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25
Elasticity	-2,96	-7,42	-3,41	-0,94	-1,58	-0,79	-1,32	-4,20
Elasticity (absolute)	2,96	7,42	3,41	0,94	1,58	0,79	1,32	4,20

Table 17: Elasticity for garages combined

Also for the garages combined, we can investigate the elasticities for separate weekdays. Looking at Table 16, we observe that the elasticities for Mondays and Sundays are larger than for the other days. As can be derived from the results, the average parking time for Mondays and Sundays decreased with 21.6 and 16.2 minutes respectively.

For Wednesdays and Fridays the demand is relatively inelastic. Wednesday's and Friday's demand both decreased with approximately 2.4, meaning that the percentage change in demand is smaller than the percentage increase in tariff.

On Tuesdays (-9.6 minute), Thursdays (-4.2 minute) and Saturdays (-3.6 minute) the demand for parking is quite elastic and comparable to the elasticity of the total. This means that the percentage decrease in demand is larger than the percentage increase in tariff.

Overall, we can conclude that the demand for garage parking in Hoorn is relatively elastic on average. Tuesdays, Thursdays and Saturdays follow the average and are comparable to the total. As opposed to Wednesdays and Fridays, which are more inelastic and less affected by the tariff change. Mondays and Sundays are more elastic, this is reflected by the observation that the effect of a price change on parking demand is larger for these days.

4.2 Elasticities for on-street parking locations in terms of parking duration

We have data on twelve on-street parking areas in Hoorn. In terms of prices, the twelve areas are divided in six different tariff-structures, as mentioned in Section 3.1.3. First, the results for individual areas with will be shown, structured on areas with the same tariff-structure. Secondly, the elasticity of total on-street parking in Hoorn will be presented. All tables are constructed in the same way, the first row represents the average parking time of an individual transaction in 2010 and 2011 and the second row contains these values for the years 2012 through 2014.

4.2.1 Tariff A: Doelenplein, Kerkplein

The first category that will be treated is the one with districts that pay tariff A. The districts in this category are Doelenplein and Kerkplein.

The calculated results for the Doelenplein area are displayed in Table 17. As can be observed, the average parking time for 2012 through 2014 was shorter than in 2010-2011. In 2010-2011 parkers parked for 0.94 hours on average, which equals 56.4 minutes. In 2012 through 2014 the parking time had an average of 0.92 hours, which equals 55.2 minutes. From these results, we can conclude that the average parking time decreased by approximately 1.2 minutes for every individual transaction (a 2.2% decrease with respect to 2010-2011). When we look at the tariff change, the tariff increased by 10.5%, from €1.90 to €2.10 per hour. Since the decrease in demand is way smaller than the increase in price, the demand for parking space in the Doelenplein area is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.16.

DOELENPLEIN	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	0,94	0,90	0,89	0,92	0,96	0,90	0,99	1,03
Avg. parking time 2012- 2014	0,92	0,90	0,88	0,89	0,94	0,89	0,95	1,02
Parking Tariff 2010-2011	1,90	1,90	1,90	1,90	1,90	1,90	1,90	1,90
Parking Tariff 2012- 2014	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Elasticity	-0,16	-0,08	-0,14	-0,29	-0,16	-0,16	-0,43	-0,07
Elasticity (absolute)	0,16	0,08	0,14	0,29	0,16	0,16	0,43	0,07

Table 18: Elasticity for Doelenplein

For the on-street parking areas, we can also investigate the elasticities for separate weekdays. Looking at Table 17 for the individual days, we observe that the elasticities magnitude is different for each day. Despite the difference in magnitudes, all weekdays display an inelastic demand. Mondays and Sundays are the most inelastic with elasticities of -0.08 and -0.07 respectively and decreases in average parking times of almost zero. Tuesdays, Thursdays and Fridays are comparable with the total elasticity. Wednesdays and Saturdays show more elastic behavior, but are still quite inelastic. The average parking time decreased with 1.8 and 2.4 minutes respectively.

The calculated results for the Kerkplein area are displayed in Table 18. As can be observed, the average parking time for 2012 through 2014 was shorter than in 2010-2011. In 2010-2011 parkers parked for 0.98 hours on average, which equals 58.8 minutes. In 2012 through 2014 the parking time had an average of 0.90 hours, which equals 54 minutes. From these results, we can conclude that the average parking time decreased by approximately 4.8 minutes for every individual transaction (a 9% decrease with respect to 2010-2011). When we look at the tariff change, the tariff increased by 10.5%, from €1.90 to €2.10 per hour. Since the decrease in demand is almost equal to the increase in price, the demand for parking space in the Kerkplein area is considered to be unit elastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -1.04.

KERKPLEIN	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	0,98	0,97	0,94	0,96	1,04	0,94	1,06	0,99
Avg. parking time 2012-1014	0,90	0,88	0,83	0,87	0,94	0,86	0,92	0,99
Parking Tariff 2010-2011	1,90	1,90	1,90	1,90	1,90	1,90	1,90	1,90
Parking Tariff 2012-2014	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Elasticity	-1,04	-1,05	-1,37	-1,00	-1,05	-1,09	-1,68	0,05
Elasticity (absolute)	1,04	1,05	1,37	1,00	1,05	1,09	1,68	0,05

Table 19: Elasticity for Kerkplein

For Kerkplein area, we can also investigate the elasticities for separate weekdays. Looking at Table 18 for the individual days, we observe that the elasticity is different for each day.
Mondays, Wednesdays, Thursdays and Fridays are all considered to be unit elastic, meaning that the percentage increase in tariff has led to an almost equal percentage decrease in demand. Tuesdays and Saturdays are more elastic, with elasticities of -1.37 and -1.68 respectively. Tuesday's demand decreased by 6.6 minutes, and Saturday's demand with 8.4 minutes. Sundays display a positive elasticity of 0.05, which is against what is expected from the theory.

If we now compare the both districts with the highest tariff (A), we observe that the demand for parking in this area is not really elastic. For Doelenplein the demand was inelastic and Kerkplein approached unit elasticity. Saturday seems to be the day with the highest elasticity and Sunday the one with the lowest elasticity.

4.2.2 Tariff B: Haven Oost, Haven West

The second category that will be treated is the one with districts that pay tariff B. The districts in this category are located near the harbor: Haven Oost and Haven West.

The calculated results for the Haven Oost area are displayed in Table 19. In 2010-2011 parkers used the garage for 1.24 hours on average, which equals 1 hour and 14.4 minutes. In 2012 through 2014 the parking time had an average of 1.19 hours, which equals 1 hour and 11.4 minutes. From these results, we can conclude that the average parking time decreased by approximately 3 minutes for every individual transaction (a 4% decrease with respect to 2010-2011). When we look at the tariff change, the tariff increased by 7.7%, from €1.30 to €1.40 per hour. Since the decrease in demand is smaller than the increase in price, the demand for parking space in the Haven Oost area is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.55.

HAVEN OOST	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	1,24	1,21	1,21	1,23	1,33	1,19	1,27	1,23
Avg. parking time 2012-1014	1,19	1,17	1,16	1,17	1,27	1,17	1,22	1,19
Parking Tariff 2010-2011	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30
Parking Tariff 2012-2014	1,40	1,40	1,40	1,40	1,40	1,40	1,40	1,40
Elasticity	-0,55	-0,52	-0,63	-0,74	-0,69	-0,24	-0,51	-0,50
Elasticity (absolute)	0,55	0,52	0,63	0,74	0,69	0,24	0,51	0,50

Table 20: Elasticity for Haven Oost

For the Haven Oost area, looking at the individual days, we observe that the elasticities are quite equal for each day. The only real exceptions are Wednesday and Friday. Wednesday is considered to be more elastic (elasticity -0.74 and average parking time decreased by 3.6 minutes) and Friday more inelastic (elasticity -0.24 and average parking time decreased by 1.2 minutes).

The calculated results for the Haven West area are displayed in Table 20. In 2010-2011 parkers used the garage for 1.27 hours on average, which equals 1 hour and 16.2 minutes. In 2012 through 2014 the parking time had an average of 1.19 hours, which equals 1 hour and 11.4 minutes. From these results, we can conclude that the average parking time decreased by approximately 4.8 minutes for every individual transaction (a 7.7% decrease with respect to 2010-2011). When we look at the tariff change, the tariff increased by 7.7%, from €1.30 to €1.40 per hour. Since the decrease in demand is almost equal to the increase in price, the demand for parking space in the Haven West area is considered to be almost unit elastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.98.

HAVEN WEST	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	1,27	1,22	1,20	1,23	1,39	1,24	1,36	1,25
Avg. parking time 2012-1014	1,19	1,11	1,12	1,13	1,27	1,10	1,40	1,16
Parking Tariff 2010-2011	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30
Parking Tariff 2012-2014	1,40	1,40	1,40	1,40	1,40	1,40	1,40	1,40
Elasticity	-0,98	-1,37	-0,97	-1,18	-1,22	-1,75	0,41	-1,07
Elasticity (absolute)	0,98	1,37	0,97	1,18	1,22	1,75	0,41	1,07

Table 21: Elasticity for Haven West

For the Haven West area, looking at the individual days, we observe that the elasticities are different for each day. The Mondays, Wednesdays, Thursdays and Fridays are more elastic than the total, with decreases in average parking time of 6.6, 6, 7.2, 8.4 minutes respectively. Tuesdays and Sundays are considered to be approximately unit elastic, like the total. Saturdays show, contrary to what is expected from the theory, an increase in average parking time of 2.4 minutes and therefore a positive relationship between price and demand.

If we now compare the both districts with the mid tariff (B), we observe that the demand for parking in this area is also not really elastic. For Haven Oost the demand was inelastic and Haven West approached unit elasticity. Hereby it has to be noted that the demand for Haven West is relatively elastic for some days of the week and therefore dependent on the weekday.

4.2.3 Tariff C/E: Lambert Meliszweg, RAC Locatie, Visserseiland

The third category that will be treated is the one with districts that pay tariff C or E. The districts in this category are Lambert Meliszweg, RAC Locatie and Visserseiland.

The calculated results for the Lambert Meliszweg area are displayed in Table 21. In 2010-2011 parkers parked for 1.79 hours on average, which equals 1 hour and 47.4 minutes. In 2012 through 2014 the parking time had an average of 1.80 hours, which equals 1 hour and 48 minutes. From these results, we can conclude that the average parking time increased by approximately 0.6 minutes for every individual transaction (a 0.6% increase with respect to 2010-2011). This contradicts with the theory, because now there is a positive relationship between price and demand.
The hourly tariff increased by 20%, from €0.50 to €0.60 per hour and the daily tariff increased by 9.5%, from €2.10 to €2.30. Since the increase in demand is way smaller than the increase in price in both cases, the elasticity is small, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals 0.04(hourly tariff) and 0.08(daily tariff).

L. MELISZWEG	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	1,79	1,63	1,79	1,85	1,72	1,83	2,05	1,64
Avg. parking time 2012-2014	1,80	1,72	1,81	1,84	1,72	1,81	1,96	1,75
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	0,04	0,29	0,05	-0,02	0,00	-0,03	-0,27	0,39
Elasticity (hour) (absolute)	0,04	0,29	0,05	0,02	0,00	0,03	0,27	0,39
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	0,08	0,56	0,09	-0,04	0,01	-0,07	-0,52	0,74
Elasticity (day) (absolute)	0,08	0,56	0,09	0,04	0,01	0,07	0,52	0,74

Table 22: Elasticity for Lambert Meliszweg

For the Lambert Meliszweg area, looking at the individual days, we observe that the elasticities are different for each day. As opposed to the total, Wednesdays, Fridays and Saturdays have a negative elasticity, meaning that the demand decreased with the increased tariff. The demand for all those three days is considered to be inelastic.

The calculated results for the RAC Locatie area are displayed in Table 22. In 2010-2011 parkers parked for 5.38 hours on average, which equals 5 hours and 22.8 minutes. In 2012 through 2014 the parking time had an average of 4.36 hours, which equals 4 hours and 21.6 minutes. From these results, we can conclude that the average parking time increased by approximately 61.2 minutes for every individual transaction (a 23.4% decrease with respect to 2010-2011).
The hourly tariff increased by 20%, from €0.50 to €0.60 per hour and the daily tariff increased by 9.5%, from €2.10 to €2.30. Since the decrease in demand is larger than the increase in price in both cases, the demand for parking space is considered to be elastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -1.41(hourly tariff) and -2.70(daily tariff).

RAC LOCATIE	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	5,38	5,27	5,72	5,39	6,33	5,74	4,30	4,20
Avg. parking time 2012-2014	4,36	4,24	4,88	4,71	5,08	4,47	3,45	2,92
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-1,41	-1,46	-1,02	-0,87	-1,47	-1,70	-1,47	-2,65
Elasticity (hour) (absolute)	1,41	1,46	1,02	0,87	1,47	1,70	1,47	2,65
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-2,70	-2,80	-1,96	-1,66	-2,83	-3,25	-2,82	-5,08
Elasticity (day) (absolute)	2,70	2,80	1,96	1,66	2,83	3,25	2,82	5,08

Table 23: Elasticity for RAC Locatie

For the RAC Locatie area, looking at the individual days, we observe that the magnitude of elasticity is different for each day. Fridays and Sundays have the highest elasticity, Wednesdays the lowest.

The calculated results for the Visserseiland area are displayed in Table 23. In 2010-2011 parkers parked for 4.77 hours on average, which equals 4 hours and 46.2 minutes. In 2012 through 2014 the parking time had an average of 3.96 hours, which equals 3 hours and 57.6 minutes. From these results, we can conclude that the average parking time increased by approximately 48.6 minutes for every individual transaction (a 17% decrease with respect to 2010-2011).
The hourly tariff increased by 20%, from €0.50 to €0.60 per hour and the daily tariff increased by 9.5%, from €2.10 to €2.30. Since the decrease in demand is larger than the increase in price in both cases, the demand for parking space is considered to be elastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -1.23(hourly tariff) and -2.35(daily tariff).

VISSERSEILAND	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	4,77	5,11	4,70	5,05	5,91	4,50	4,34	3,68
Avg. parking time 2012-2014	3,96	4,26	3,85	3,84	4,80	3,92	3,67	3,36
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-1,23	-1,20	-1,32	-1,90	-1,39	-0,90	-1,08	-0,58
Elasticity (hour) (absolute)	1,23	1,20	1,32	1,90	1,39	0,90	1,08	0,58
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-2,35	-2,31	-2,53	-3,63	-2,66	-1,73	-2,08	-1,11
Elasticity (day) (absolute)	2,35	2,31	2,53	3,63	2,66	1,73	2,08	1,11

Table 24: Elasticity for Visserseiland

Also for the Visserseiland area, looking at the individual days, we observe that the magnitude of elasticity is different for each day. Wednesdays have the highest elasticity, Fridays and Sundays the lowest.

If we now compare the both districts with the tariffs C and E, we observe that the demand for parking in these areas is relatively elastic, except for the Lambert Meliszweg. For the RAC Locatie Fridays and Sundays have the highest elasticity and Wednesdays the lowest, while for Visserseiland it is exactly the other way around: Wednesdays have the highest elasticity, Fridays and Sundays the lowest.

4.2.4 Tariff D: Pelmolenpad, Transferium

The fourth category that should be treated is the one with districts that pay tariff D. The districts in this category are Pelmolenpad and Transferium. Since both locations do not have a time registration mechanism, we do not have data on the average duration of individual transactions. Therefore only the average daily amount of parkers will be discussed for the locations with tariff structure D. This will be done in Section 4.4.4.

4.2.5 Tariff F: Westvries

The fifth category that will be treated is the one with district that pays tariff F. The district in this category is Westvries.

The calculated results for the Westfries area are displayed in Table 24. In 2010-2011 parkers parked for 8.44 hours on average, which equals 8 hours and 26.4 minutes. In 2012 through 2014 the parking time had an average of 7.51 hours, which equals 7 hours and 30.6 minutes. From these results, we

can conclude that the average parking time decreased by approximately 55.8 minutes for every individual transaction (an 11% decrease with respect to 2010-2011). When we look at the tariff change, the tariff increased by 20%, from €1.00 to €1.20 per day. Since the decrease in demand is smaller than the increase in price, the demand for parking space is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.74.

WESTVRIES	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	8,44	6,96	6,78	7,61	6,94	8,17	11,51	11,14
Avg. parking time 2012-1014	7,51	6,42	6,15	6,89	6,30	6,85	10,16	9,98
Parking Tariff 2010-2011	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Parking Tariff 2012-2014	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20
Elasticity	-0,74	-0,51	-0,61	-0,63	-0,61	-1,15	-0,79	-0,70
Elasticity (absolute)	0,74	0,51	0,61	0,63	0,61	1,15	0,79	0,70

Table 25: Elasticity for Westvries

For the Westvries area, looking at the individual days, we observe that most days are inelastic, like the total. The only exceptions are Fridays, which are relatively elastic with an elasticity of -1.15, meaning that with the price increase, parking duration decreased with 1 hour and 19.2 minutes.

4.2.6 Tariff A+C: Grote Noord, Veemarkt

The sixth category that will be treated is the one with districts that pay tariffs A and C. The districts in this category are Grote Noord and Veemarkt. The results will be presented for both tariffs.

The calculated results for the Grote Noord area are displayed in Table 25 and 26. In 2010-2011 parkers parked for 1.50 hours on average, which equals 1 hour and 30 minutes. In 2012 through 2014 the parking time had an average of 1.42 hours, which equals 1 hour and 25.2 minutes. From these results, we can conclude that the average parking time decreased by approximately 4.8 minutes for every individual transaction (a 5.3% decrease with respect to 2010-2011).
When we look at the tariff change for tariff A (Table 14), the tariff increased by 10.5%, from €1.90 to €2.10 per day. Since the decrease in demand is smaller than the increase in price, the demand for parking space is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.65.
When we look at the tariff change for tariff C (Table 15) the hourly tariff increased by 20% from €0.50 to €0.60 per hour and the daily tariff increased by 9.5% from €2.10 to €2.30. Since the decrease in demand is smaller than the increase in price in both cases, the demand for parking space is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.37 (hourly tariff) and -0.71 (daily tariff).

GROTE NOORD	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	1,50	1,40	1,49	1,51	1,55	1,46	1,66	1,46
Avg. parking time 2012-1014	1,42	1,37	1,41	1,40	1,47	1,38	1,55	1,34
Parking Tariff 2010-2011	1,90	1,90	1,90	1,90	1,90	1,90	1,90	1,90
Parking Tariff 2012-2014	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Elasticity (hour)	-0,65	-0,22	-0,64	-0,81	-0,54	-0,59	-0,79	-0,92
Elasticity (hour), (absolute)	0,65	0,22	0,64	0,81	0,54	0,59	0,79	0,92

Table 26: Elasticity for Grote Noord (tariff A)

GROTE NOORD	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	1,50	1,40	1,49	1,51	1,55	1,46	1,66	1,46
Avg. parking time 2012-2014	1,42	1,37	1,41	1,40	1,47	1,38	1,55	1,34
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-0,37	-0,13	-0,36	-0,46	-0,31	-0,34	-0,45	-0,52
Elasticity (hour) (absolute)	0,37	0,13	0,36	0,46	0,31	0,34	0,45	0,52
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-0,71	-0,25	-0,70	-0,89	-0,59	-0,65	-0,87	-1,00
Elasticity (day) (absolute)	0,71	0,25	0,70	0,89	0,59	0,65	0,87	1,00

Table 27: Elasticity for Grote Noord (tariff C)

For the Grote Noord area, looking at the individual days, we observe that all days are inelastic, and the only differences are in magnitude. Mondays and Thursdays are the most inelastic days, Wednesdays, Saturdays and Sundays are less inelastic.

The calculated results for the Veemarkt area are displayed in Table 27 and 28. In 2010-2011 parkers parked for 1.20 hours on average, which equals 1 hour and 12 minutes. In 2012 through 2014 the parking time had an average of 1.10 hours, which equals 1 hour and 6 minutes. From these results, we can conclude that the average parking time decreased by approximately 6 minutes for every individual transaction (an 8.3% decrease with respect to 2010-2011).

When we look at the tariff change for tariff A (Table 14), the tariff increased by 10.5%, from €1.90 to €2.10 per day. Since the decrease in demand is smaller than the increase in price, the demand for parking space is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.94.

When we look at the tariff change for tariff C (Table 15) the hourly tariff increased by 20% from €0.50 to €0.60 per hour and the daily tariff increased by 9.5% from €2.10 to €2.30. Since the decrease in demand is smaller than the increase in price in first case and almost equal in the second case, the demand for parking space is considered to be inelastic to unit elastic, this can also be seen in the

table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.54(hourly tariff) and -1.03(daily tariff).

VEEMARKT	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	1,20	1,11	1,12	1,19	1,23	1,13	1,41	1,22
Avg. parking time 2012-1014	1,10	1,03	1,02	1,08	1,14	1,03	1,29	1,14
Parking Tariff 2010-2011	1,90	1,90	1,90	1,90	1,90	1,90	1,90	1,90
Parking Tariff 2012-2014	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Elasticity	-0,94	-0,88	-1,05	-1,04	-0,83	-0,96	-0,98	-0,81
Elasticity (absolute)	0,94	0,88	1,05	1,04	0,83	0,96	0,98	0,81

Table 28: Elasticity for Veemarkt (tariff A)

VEEMARKT	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	1,20	1,11	1,12	1,19	1,23	1,13	1,41	1,22
Avg. parking time 2012-2014	1,10	1,03	1,02	1,08	1,14	1,03	1,29	1,14
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-0,54	-0,51	-0,60	-0,60	-0,48	-0,55	-0,56	-0,46
Elasticity (hour) (absolute)	0,54	0,51	0,60	0,60	0,48	0,55	0,56	0,46
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-1,03	-0,97	-1,15	-1,14	-0,91	-1,06	-1,08	-0,89
Elasticity (day) (absolute)	1,03	0,97	1,15	1,14	0,91	1,06	1,08	0,89

Table 29: Elasticity for Veemarkt (tariff C)

For the Veemarkt area, looking at the individual days under the high tariff (A), we observe that some days are inelastic and some elastic. Tuesdays and Wednesdays are a little more elastic compared to the total and Thursdays and Sundays less elastic.
Looking at the individual days under the lower tariff (C), we observe inelastic demand for the hourly tariff and more elastic demand under the daily tariff. Thursdays and Sundays have the lowest elasticities, while Tuesdays and Wednesdays have the highest.

When we look at the areas that have the tariffs A and C combined, we observe that the elasticities are quite inelastic. For the Grote Noord area, all days are inelastic, and the only differences are in magnitude. For the Veemarkt area, there is some more division between the days in terms of elasticity. Overall, Thursdays seem to be the most inelastic days and Tuesdays the most elastic.

4.2.7 On-street areas combined

The calculated results for the on-street parking locations combined are displayed in Table 29. As it can be observed, the average parking time for 2012 through 2014 was shorter than in 2010-2011. In 2010-2011 parkers parked for 4.93 hours on average, which equals 4 hours and 55.8 minutes. In 2012

through 2014 the parking time had an average of 4.55 hours, which equals 4 hours and 33 minutes. From these results, we can conclude that the average parking time decreased by approximately 22.8 minutes for every individual transaction (a 7.7% decrease with respect to 2010-2011). The high tariff increased by 11.4%, from €0.88 to €0.98 per hour, and the low tariff increased by 9.5% from €0.74 to €0.81. The decrease in demand is slightly smaller than the increase in price, therefore demand for parking space for on-street locations is considered to be relatively inelastic, which can also be seen in the table. The price elasticity equals -0.82 for the high tariff and -0.97 for the low tariff.

COMBINED	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Avg. parking time 2010-2011	4,93	4,94	4,34	4,35	4,18	4,03	4,61	8,04
Avg. parking time 2012-2014	4,55	4,61	4,19	4,18	3,96	3,93	4,14	6,81
Parking Tariff 2010-2011	0,88	0,88	0,88	0,88	0,88	0,88	0,88	0,88
Parking Tariff 2012-2014	0,98	0,98	0,98	0,98	0,98	0,98	0,98	0,98
Elasticity (hour)	-0,82	-0,71	-0,35	-0,39	-0,56	-0,26	-1,10	-1,78
Elasticity (hour) (absolute)	0,82	0,71	0,35	0,39	0,56	0,26	1,10	1,78
Parking Tariff 2010-2011	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74
Parking Tariff 2012-2014	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81
Elasticity (day)	-0,97	-0,84	-0,42	-0,46	-0,66	-0,31	-1,30	-2,10
Elasticity (day) (absolute)	0,97	0,84	0,42	0,46	0,66	0,31	1,30	2,10

Table 30: Elasticity for combined on-street parking locations

Looking at the on-street parking locations combined, we observe that all weekdays are inelastic, except for the weekend. Tuesdays and Fridays are the least elastic, with reductions in parking duration of respectively 9 and 6 minutes. Saturdays and Sundays faced decreases in parking duration of 28.2 and 73.8 minutes respectively and are the most elastic in terms of demand.

4.3 Elasticities for Garages in terms of amount of parkers

As mentioned before, we have data on two parking garages in Hoorn: Jeudje and Schouwburg. First, the results for the separate garages will be shown. Secondly, the elasticity of the combined parking supply of garages in Hoorn will be presented. All tables are structured in the same way, the first row represents the daily average amount of parkers in 2012 and the second row contains these values for the years 2013 and 2014 combined.

4.3.1 Jeudje

The calculated results for the Jeudje garage are displayed in Table 30. As can be observed, the amount of parkers for 2013 and 2014 was larger than in 2012. In 2012 the garage was used by 401 parkers per day on average, in 2013 and 2014 there were 413 parkers per day. From these results, we can conclude that the average amount of parking visits increased by 12 parkers per day, this is a 3% increase. When we look at the tariff change, the tariff increased by 2.5%, from €1.22 to €1.25 per hour. Due to the fact that the average amount of parkers in 2013 and 2014 was larger than in 2012, even though the tariff was higher in these years, the elasticity is larger than zero. This means a positive relationship between price and demand, contrary to what one expects from the theory: a lower demand leading from a higher price. The price elasticity for the total years of 2013 and 2014 with respect to 2012 equals 1.35.

JEUDJE	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2012	401	246	352	435	501	454	688	142
Average parkers 2013, 2014	413	254	372	457	480	456	706	166
Parking Tariff 2012	1,22	1,22	1,22	1,22	1,22	1,22	1,22	1,22
Parking Tariff 2013, 2014	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25
Elasticity	1,35	1,56	2,63	2,34	-2,14	0,28	1,21	6,88
Elasticity (absolute)	1,35	1,56	2,63	2,34	2,14	0,28	1,21	6,88

Table 31: Elasticity for Jeudje garage

Now we have the price elasticity of the years in totality, we can also investigate the elasticities for separate weekdays. For instance, a Monday in 2013-2014 compared to a Monday in 2012. Looking at Table 30 for the individual days, we observe that the elasticities are quite different for each day.

As we can observe, the elasticity for Thursdays is the only negative one. This means that the average amount of daily parkers decreased. Looking at the table, we can see that 21 parkers less visited the garage in 2013-2014 with respect to 2012, a 4.2% decrease.
Another result that catches the eye is that the elasticity for Sundays is way larger (almost 5 times) than for the other days. As can be derived from the results, the average parking visits per day for Sundays increased with 24 parkers (16.9%). We will try to explain this increase in Section 5.1.

The other weekdays are comparable to the total. On Mondays (+8 parkers), Tuesdays (+20 parkers), Wednesdays (+22 parkers) and Saturdays (+18 parkers), the percentage increase in demand is larger than the percentage increase in tariff. Because this is a positive relationship between price and demand, it is again not what is expected from the theory.
Overall, we can conclude that the average amount of parkers increased in the years 2013-2014 with respect to 2012, except for Tuesdays.

4.3.2 Schouwburg

The calculated results for the Schouwburg garage are displayed in Table 31. As can be observed, the amount of parkers for 2013 and 2014 was larger than in 2012. In 2012 the garage was used by 159 parkers per day on average, in 2013 and 2014 there were 162 parkers per day. From these results, we can conclude that the average amount of parking visits increased by 3 parkers per day, this is a 2.2% increase. When we look at the tariff change, the tariff increased by 2.5%, from €1.22 to €1.25 per hour. Since there is an increase in demand and an increase in price, the elasticity is larger than zero. This means a positive relationship between price and demand, contrary to what one expects from the theory: a lower demand leading from a higher price. The price elasticity for the total years of 2013 and 2014 with respect to 2012 equals 1.01.

SCHOUWBURG	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2012	159	91	130	149	174	177	305	91
Average parkers 2013, 2014	162	92	138	163	178	174	301	87
Parking Tariff 2012	1,22	1,22	1,22	1,22	1,22	1,22	1,22	1,22
Parking Tariff 2013, 2014	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25
Elasticity	1,01	0,75	2,96	4,12	1,12	-0,59	-0,62	-2,17
Elasticity (absolute)	1,01	0,75	2,96	4,12	1,12	0,59	0,62	2,17

Table 32: Elasticity for Schouwburg garage

Again, we can also investigate the elasticities for separate weekdays. Looking at Table 31 for the individual days, we observe that the elasticities are quite different for each day.

As we can observe, the elasticities for Fridays, Saturdays and Sundays are the only negative ones. This means that the average amount of daily parkers decreased. Looking at the table, we can see that respectively 3, 4 and 4 parkers less visited the garage in 2013-2014 with respect to 2012, a 1.7%, 1.3% and 4.4% decrease. Sundays are considered to be elastic, while Fridays and Saturdays are inelastic. All other days show a positive elasticity, which means a positive relationship between price and demand. This again is not what is expected from the theory.
In terms of magnitude the elasticities for Tuesdays and Wednesdays and are way larger than the total. As can be derived from the results, the average parking visits per day for Tuesdays and

Wednesdays increased with 8 (6.2%) and 14 parkers (9.4%). Mondays (+1 parker) and Thursdays (+4 parkers) are more comparable to the total. Overall, we can conclude that the average amount of parkers increased in the years 2013-2014 with respect to 2012, except for the weekend and Fridays.

4.3.3 Garages combined

The calculated results for the garages combined are displayed in Table 32. As can be observed, the amount of parkers for 2013 and 2014 was larger than in 2012. In 2012 the garage was used by 559 parkers per day on average, in 2013 and 2014 there were 575 parkers per day. From these results, we can conclude that the average amount of parking visits increased by 16 parkers per day, this is a 2.9% increase. When we look at the tariff change, the tariff increased by 2.5%, from €1.22 to €1.25 per hour. Due to the fact that the average amount of parkers in 2013 and 2014 was larger than in 2012, even though the tariff was higher in these years, the elasticity is larger than zero. This means a positive relationship between price and demand, contrary to what one expects from the theory. The price elasticity for the total years of 2013 and 2014 with respect to 2012 equals 1.35.

COMBINED	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2012	559	335	481	585	674	630	993	224
Average parkers 2013, 2014	575	346	510	620	658	630	1.006	252
Parking Tariff 2012	1,22	1,22	1,22	1,22	1,22	1,22	1,22	1,22
Parking Tariff 2013, 2014	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25
Elasticity	1,35	1,59	2,72	2,81	-1,26	0,04	0,66	5,52
Elasticity (absolute)	1,35	1,59	2,72	2,81	1,26	0,04	0,66	5,52

Table 33: Elasticity for garages combined

Looking at Table 32 for the individual days, we observe that the elasticities differ for each day.
As we can observe, the elasticity for Thursdays is the only negative one. This means that the average amount of daily parkers decreased. Looking at the table, we can see that respectively 16 parkers less visited the garage in 2013-2014 with respect to 2012, a 2.4% decrease. Thursday is considered to be relatively elastic. All other weekdays show a positive relationship between price and demand, which is contradicting with the theory.
In terms of magnitude the elasticities for Tuesdays, Wednesdays and Sundays are way larger than the total. As can be derived from the results, the average parking visits per day for Tuesdays, Wednesdays and Sundays increased with 29 (6%), 35 parkers (6%) and 28 (12.5%).
Mondays are comparable to the total with an increase of 11 parkers. Fridays and Saturdays faced the smallest increases in amount of parkers.
Overall, we can conclude that the average amount of parkers increased in the years 2013-2014 with respect to 2012, except for Thursdays. The largest increase in average daily parkers is on Sundays.

4.4 Elasticities for on-street parking locations

As mentioned before, we have data on twelve on-street parking areas in Hoorn. In terms of prices, the twelve areas are divided in six different tariff-structures, as mentioned in Section 3.1.3. First, the results for individual areas with will be shown, structured on areas with the same tariff-structure. Secondly, the elasticity of total on-street parking in Hoorn will be presented. The same categorization as in Section 4.2 will be used for the tariffs. All tables will be structured in the same way, the first row represents the average daily amount of parkers in 2010 and 2011 and the second row contains these values for the years 2012 through 2014.

4.4.1 Tariff A: Doelenplein, Kerkplein

Again, the first category that will be treated is the one with districts that pay tariff A. The districts in this category are Doelenplein and Kerkplein.

The calculated results for the Doelenplein area are displayed in Table 33. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 138 parkers per day and in 2012 through 2014 this average was 123 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 10.9%. When we look at the tariff change, the tariff increased by 10.5%, from €1.90 to €2.10 per hour. Since the decrease in demand is larger than the increase in price, the demand for parking space in the Doelenplein area is considered to be elastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -1.30.

DOELENPLEIN	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	138	93	133	148	183	157	182	30
Average parkers 2012-2014	123	86	122	137	160	144	168	25
Parking Tariff 2010-2011	1,90	1,90	1,90	1,90	1,90	1,90	1,90	1,90
Parking Tariff 2012-2014	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Elasticity	-1,30	-0,89	-0,95	-0,83	-1,51	-0,94	-0,85	-2,16
Elasticity (absolute)	1,30	0,89	0,95	0,83	1,51	0,94	0,85	2,16

Table 34: Elasticity for Doelenplein

Looking at Table 33 for the individual days, we observe that the elasticities magnitude is different for each day. Despite the difference in magnitudes, all weekdays display a decrease in average daily amount of parkers.

Thursdays and Sundays are the most elastic with elasticities of -1.51 and -2.16 respectively and decreases in average amount of parkers of 23 (12.6%) and 5 (16.7%). All other weekdays can be considered as inelastic, which is contradictory to the total. As can be seen, Wednesdays and Saturdays are the most inelastic, with elasticities of -0.83 and -0.85 respectively.

The calculated results for the Kerkplein area are displayed in Table 34. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 217 parkers per day and in 2012 through 2014 this average was 206 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 5.1%. When we look at the tariff change, the tariff increased by 10.5%, from €1.90 to €2.10 per hour. Since the decrease in demand is smaller than the increase in price, the demand for parking space in the Kerkplein area is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.55.

KERKPLEIN	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	217	160	226	237	333	265	212	38
Average parkers 2012-2014	206	156	207	230	309	250	216	45
Parking Tariff 2010-2011	1,90	1,90	1,90	1,90	1,90	1,90	1,90	1,90
Parking Tariff 2012-2014	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Elasticity	-0,55	-0,27	-0,92	-0,29	-0,83	-0,65	0,20	1,65
Elasticity (absolute)	0,55	0,27	0,92	0,29	0,83	0,65	0,20	1,65

Table 35: Elasticity for Kerkplein

Looking at Table 34 for the individual days, we observe that the elasticities magnitude is different for each day. Next to the difference in magnitudes, there is a difference in the sign of the elasticities. In the weekend, the elasticity is larger than zero, meaning that the average daily amount of parkers increased for Saturdays and Sundays, as opposed to the rest of the week, for which it has decreased. This is contradicting with the theory, because it shows a positive relationship between price and demand. Mondays and Wednesdays are the most inelastic with elasticities of -0.27 and -0.29 respectively and decreases in average amount of parkers of 4 (2.5%) and 7 (3%). Tuesdays and Thursdays are the least inelastic, with elasticities of -0.92 and -0.83 respectively.

If we now compare the both districts with the highest tariff (A), we observe that the demand for parking in this area is not really elastic. For Doelenplein the demand was elastic in total, but inelastic for most of the days. The Kerkplein area also displayed an inelastic demand. Thursday seems to be the day with the highest elasticity and Wednesday the one with the lowest elasticity.

4.4.2 Tariff B: Haven Oost, Haven West

We will now analyze the districts that pay tariff B. The districts in this category are located near the harbor: Haven Oost and Haven West.

The calculated results for the Haven Oost area are displayed in Table 35. As can be observed, the average daily amount of parkers for 2012 through 2014 was larger than in 2010-2011. In 2010-2011 the average was 45 parkers per day and in 2012 through 2014 this average was 46 parkers. From

these results, we can conclude that the average amount of parkers increased by approximately 2.2%. When we look at the tariff change, the tariff increased by 7.7%, from €1.30 to €1.40 per hour. Due to the fact that the average amount of parkers in 2012-2014 was larger than in 2010-2011, even though the tariff was higher in these years, the elasticity is larger than zero. This means a positive relationship between price and demand, contrary to what one expects from the theory. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals 0.33.

HAVEN OOST	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	45	40	47	49	61	49	49	9
Average parkers 2012-2014	46	41	46	52	64	53	49	13
Parking Tariff 2010-2011	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30
Parking Tariff 2012-2014	1,40	1,40	1,40	1,40	1,40	1,40	1,40	1,40
Elasticity	0,33	0,05	-0,06	0,69	0,54	1,08	-0,17	4,06
Elasticity (absolute)	0,33	0,05	0,06	0,69	0,54	1,08	0,17	4,06

Table 36: Elasticity for Haven Oost

Looking at Table 35 for the individual days, we observe that on every day, except Tuesday and Saturday, the demand has increased. Both days are considered to be inelastic. All other weekdays show a positive relationship between price and demand, which is contradicting with the theory. On Sundays the increase in average daily amount of parkers is the largest, with 44.4%. On Mondays the increase is the smallest, with 2.5%.

The calculated results for the Haven West area are displayed in Table 36. As can be observed, the average daily amount of parkers for 2012 through 2014 was larger than in 2010-2011. In 2010-2011 the average was 25 parkers per day and in 2012 through 2014 this average was 27 parkers. From these results, we can conclude that the average amount of parkers increased by approximately 8%. When we look at the tariff change, the tariff increased by 7.7%, from €1.30 to €1.40 per hour. Since there is an increase in demand resulting from the increase in price, the demand for parking space in the Haven West area is considered is larger than zero, which violates the theory. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals 1.02.

HAVEN WEST	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	25	20	23	26	36	26	30	8
Average parkers 2012-2014	27	21	26	28	37	32	32	10
Parking Tariff 2010-2011	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30
Parking Tariff 2012-2014	1,40	1,40	1,40	1,40	1,40	1,40	1,40	1,40
Elasticity	1,02	1,15	1,26	1,13	0,51	2,49	0,81	2,30
Elasticity (absolute)	1,02	1,15	1,26	1,13	0,51	2,49	0,81	2,30

Table 37: Elasticity for Haven West

Looking at Table 36 for the individual days, we observe that on every day the demand has increased. This means that all days show a positive relationship between price and demand, which is not expected from the theory. On Sundays the increase in average daily amount of parkers is the largest, with 25%. Thursdays and Saturdays, with increases in demand of 2.8% and 6.7% respectively, are the days with the smallest demand increases.

If we now compare the both districts with the mid tariff (B), we observe that the demand for parking in this area has increased. For Haven Oost the demand was inelastic and Haven West can be considered as unit elastic. Sundays seem to be the days with the largest increase in demand and Saturdays increased the least in terms of average daily amount of parkers.

4.4.3 Tariff C/E: Lambert Meliszweg, RAC Locatie, Visserseiland

The third category that will be treated is the one with districts Lambert Meliszweg, RAC Locatie and Visserseiland, that pay tariff C or E.

The calculated results for the Lambert Meliszweg area are displayed in Table 37. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 85 parkers per day and in 2012 through 2014 this average was 62 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 27.1%. The hourly tariff increased by 20%, from €0.50 to €0.60 per hour and the daily tariff increased by 9.5%, from €2.10 to €2.30. Since the decrease in demand is larger than the increase in price, the demand for parking space in the Lambert Meliszweg area is considered to be relatively elastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -2.26 (hourly tariff) and -4.34 (daily tariff).

L. MELISZWEG	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	85	37	50	67	128	69	201	34
Average parkers 2012-2014	62	28	35	49	82	49	153	31
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-2,26	-2,16	-2,48	-2,32	-3,38	-2,37	-1,87	-0,55
Elasticity (hour) (absolute)	2,26	2,16	2,48	2,32	3,38	2,37	1,87	0,55
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-4,34	-4,14	-4,75	-4,44	-6,48	-4,54	-3,59	-1,05
Elasticity (day) (absolute)	4,34	4,14	4,75	4,44	6,48	4,54	3,59	1,05

Table 38: Elasticity for Lambert Meliszweg

Looking at Table 37 for the individual days, we observe that on every day the demand has decreased. On Sundays the decrease in average daily amount of parkers is the smallest, with only 8.8%, therefore Sundays are considered to be inelastic (hourly tariff) or almost unitary elastic (daily tariff). Thursday is the day with the highest elasticity: -3.38(hourly) or -6.48(daily), with a daily average decrease in parkers of 35.9%. Mondays, Tuesdays, Wednesdays, Fridays and Saturdays are also all elastic and comparable to the total in terms of magnitude.

The calculated results for the RAC Locatie area are displayed in Table 38. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 54 parkers per day and in 2012 through 2014 this average was 41 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 24.1%. The hourly tariff increased by 20%, from €0.50 to €0.60 per hour and the daily tariff increased by 9.5%, from €2.10 to €2.30. Since the decrease in demand is larger than the increase in price, the demand for parking space in the RAC Locatie area is considered to be relatively elastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -2.01 (hourly tariff) and -3.85 (daily tariff).

RAC LOCATIE	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	54	41	51	49	65	48	85	24
Average parkers 2012-2014	41	34	36	38	46	36	66	16
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-2,01	-1,30	-2,38	-1,84	-2,45	-2,01	-1,69	-3,05
Elasticity (hour) (absolute)	2,01	1,30	2,38	1,84	2,45	2,01	1,69	3,05
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-3,85	-2,49	-4,57	-3,53	-4,70	-3,85	-3,24	-5,85
Elasticity (day) (absolute)	3,85	2,49	4,57	3,53	4,70	3,85	3,24	5,85

Table 39: Elasticity for RAC Locatie

Looking at Table 38 for the individual days, we observe that on every day the demand has decreased. On Sundays the decrease in average daily amount of parkers is the largest, with 33.3%, therefore Sundays are considered to be elastic. Monday is the day with the lowest elasticity: -1.30(hourly) or -2.49(daily), with a daily average decrease in parkers of 17.1%. Tuesdays, Wednesdays, Thursdays Fridays and Saturdays are also all elastic and comparable to the total in terms of magnitude.

The calculated results for the Visserseiland area are displayed in Table 39. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 32 parkers per day and in 2012 through 2014 this average was 30 parkers. From

these results, we can conclude that the average amount of parkers decreased by approximately 6.3%. The hourly tariff increased by 20%, from €0.50 to €0.60 per hour and the daily tariff increased by 9.5%, from €2.10 to €2.30. Since the decrease in demand is smaller than the increase in price, the demand for parking space in the Visserseiland area is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.24 (hourly tariff) and -0.45 (daily tariff).

VISSERSEILAND	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	32	20	36	31	40	41	42	9
Average parkers 2012-2014	30	17	31	30	39	38	47	10
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-0,24	-1,01	-1,00	-0,22	-0,12	-0,51	0,70	0,68
Elasticity (hour) (absolute)	0,24	1,01	1,00	0,22	0,12	0,51	0,70	0,68
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-0,45	-1,93	-1,92	-0,42	-0,22	-0,97	1,34	1,31
Elasticity (day) (absolute)	0,45	1,93	1,92	0,42	0,22	0,97	1,34	1,31

Table 40: Elasticity for Visserseiland

Looking at Table 39 for the individual days, we observe that on every day the demand has decreased, except for the weekends. On Mondays and Tuesdays the decrease in average daily amount of parkers is the largest, with 15% and 13.8% respectively, therefore these days are considered to be elastic. Wednesdays, Thursdays and Fridays are the ones with small changes in average daily amount of parkers. The decreases are with 3.3%, 2.5% and 7.3% respectively, when comparing this to the increase in tariff, these days are considered to be inelastic. Saturdays and Sundays have faced increases in the amount of daily parkers of 11.9% and 11.1% respectively and therefore show a positive relationship between price and demand, which is contradictory to the theory.

If we now compare the both districts with the tariffs C and E, we observe that the demand for parking in these areas is elastic, except for the Visserseiland area. For the Lambert Meliszweg, Sunday is the least elastic, and for RAC Locatie Sundays has the highest elasticity.

4.4.4 Tariff D: Pelmolenpad, Transferium

The fourth category that will be treated is the one with districts that pay the daily tariff D. The districts in this category are Pelmolenpad and Transferium.

The calculated results for the Pelmolenpad area are displayed in Table 40. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011

the average was 271 parkers per day and in 2012 through 2014 this average was 216 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 20.3% and the daily tariff increased by 9.5%, from €2.10 to €2.30. Since the decrease in demand is larger than the increase in price, the demand for parking space in the Pelmolenpad area is considered to be elastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -2.95.

PELMOLENPAD	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	271	146	241	284	365	264	497	88
Average parkers 2012-2014	216	127	184	210	265	211	411	93
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity	-2,95	-1,69	-3,55	-4,05	-4,36	-2,87	-2,41	0,61
Elasticity (absolute)	2,95	1,69	3,55	4,05	4,36	2,87	2,41	0,61

Table 41: Elasticity for Pelmolenpad

Looking at Table 40 for the individual days, we observe that on every day the demand has decreased, except for Sundays. On Mondays the decrease in average daily amount of parkers is the smallest, with 13%, but with an elasticity of -1.69, still considered to be elastic. Wednesdays and Thursdays are the ones with large changes in average daily amount of parkers. The decreases are with 26.1% and 27.4% respectively. All other days, except for Sundays are comparable to the total and therefore elastic. Sundays have faced an increase in the amount of daily parkers of 5.7%, and therefore shows a positive relationship between price and demand, which is contradictory to the theory.

The calculated results for the Transferium area are displayed in Table 41. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 657 parkers per day and in 2012 through 2014 this average was 627 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 4.6% and the daily tariff increased by 9.5%, from €2.10 to €2.30. Since the decrease in demand is smaller than the increase in price, the demand for parking space in the Transferium area is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.56.

TRANSFERIUM	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	657	682	724	739	870	720	728	134
Average parkers 2012-2014	627	660	712	716	823	691	644	138
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity	-0,56	-0,38	-0,20	-0,37	-0,65	-0,47	-1,50	0,30
Elasticity (absolute)	0,56	0,38	0,20	0,37	0,65	0,47	1,50	0,30

Table 42: Elasticity for Transferium

Looking at Table 41 for the individual days, we observe that on every day the demand has decreased, except for Sundays. On Tuesdays the decrease in average daily amount of parkers is the smallest with 1.7% and, with an elasticity of -0.20, considered to be inelastic. Saturday is the day with the largest changes in average daily amount of parkers, with a decrease of 11.5%. The elasticity for Saturdays equals -1.50 and is therefore considered to be elastic. All other days, except for Sundays are comparable to the total and therefore inelastic. Sundays have faced an increase in the amount of daily parkers of 3%, and therefore show a positive relationship between price and demand, which is contradictory to the theory.

If we now compare the both districts with the tariff D, we observe that the demand for parking in the Pelmolenpad area is very elastic, except for Sundays, and quite inelastic for the Transferium area, also except for Sundays. For both areas the parking demand decreased for all weekdays, except for Sundays, which faced an increase in the average daily amount of parkers.

4.4.5 Tariff F: Westvries

The fifth category is a single-area district, Westfries. The tariff to be paid is F.

The calculated results for the Westvries area are displayed in Table 42. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 204 parkers per day and in 2012 through 2014 this average was 165 parkers. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -1.40 and is therefore considered to be elastic.

WESTVRIES	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	204	177	181	189	163	168	313	236
Average parkers 2012-2014	165	124	129	148	125	164	263	206
Parking Tariff 2010-2011	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Parking Tariff 2012-2014	1,20	1,20	1,20	1,20	1,20	1,20	1,20	1,20
Elasticity	-1,40	-2,52	-2,47	-1,64	-1,78	-0,13	-1,12	-0,89
Elasticity (absolute)	1,40	2,52	2,47	1,64	1,78	0,13	1,12	0,89

Table 43: Elasticity for Westvries

Looking at Table 42 for the individual days, we observe that on every day the demand has decreased. On Mondays and Tuesdays the decrease in average daily amount of parkers is the largest with 42.7% and 40.3% respectively and therefore considered to be elastic. Fridays and Sundays are the days with the smallest changes in average daily amount of parkers, with decreases of 2.4% and 12.7%. The elasticities for Fridays and Sundays equal -0.13 and -0.89 respectively and therefore both these days are considered to be inelastic. All other days are comparable to the total and therefore elastic.

4.4.6 Tariff A+C: Grote Noord, Veemarkt

The sixth category that will be treated is the one with districts that pay tariffs A and C. The districts in this category are Grote Noord and Veemarkt. The results will be presented for both tariffs.

The calculated results for the Grote Noord area are displayed in Table 43 and 44. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 466 parkers per day and in 2012 through 2014 this average was 440 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 5.6%. When we look at the tariff change for tariff A (Table 14), the tariff increased by 10.5%, from €1.90 to €2.10 per day. Since the decrease in demand is smaller than the increase in price, the demand for parking space is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.62.
When we look at the tariff change for tariff C (Table 15) the hourly tariff increased by 20% from €0.50 to €0.60 per hour and the daily tariff increased by 9.5% from €2.10 to €2.30. Since the decrease in demand is smaller than the increase in price in both cases, the demand for parking space is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.35(hourly tariff) and -0.67(daily tariff).

GROTE NOORD	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	466	313	452	520	711	525	643	97
Average parkers 2012-2014	440	310	426	468	638	496	630	115
Parking Tariff 2010-2011	1,90	1,90	1,90	1,90	1,90	1,90	1,90	1,90
Parking Tariff 2012-2014	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Elasticity	-0,62	-0,11	-0,64	-1,16	-1,21	-0,61	-0,21	1,60
Elasticity (absolute)	0,62	0,11	0,64	1,16	1,21	0,61	0,21	1,60

Table 44: Elasticity for Grote Noord (tariff A)

GROTE NOORD	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	466	313	452	520	711	525	643	97
Average parkers 2012-2014	440	310	426	468	638	496	630	115
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-0,35	-0,06	-0,37	-0,66	-0,69	-0,35	-0,12	0,91
Elasticity (hour) (absolute)	0,35	0,06	0,37	0,66	0,69	0,35	0,12	0,91
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-0,67	-0,12	-0,70	-1,27	-1,33	-0,66	-0,23	1,75
Elasticity (day) (absolute)	0,67	0,12	0,70	1,27	1,33	0,66	0,23	1,75

Table 45: Elasticity for Grote Noord (tariff C)

For the Grote Noord area, looking at the individual days, we observe that all days, except Sundays, faced a decrease in the daily amount of parkers. Mondays, Tuesdays, Fridays and Saturdays are inelastic. Wednesdays, Thursdays are considered to be relatively elastic. Sundays show a positive relationship between price and demand, which is contradictory to the theory.

The calculated results for the Veemarkt area are displayed in Table 45 and 46. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 1694 parkers per day and in 2012 through 2014 this average was 1571 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 7.3%. When we look at the tariff change for tariff A (Table 14), the tariff increased by 10.5%, from €1.90 to €2.10 per day. Since the decrease in demand is smaller than the increase in price, the demand for parking space is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.82.
When we look at the tariff change for tariff C (Table 15) the hourly tariff increased by 20% from €0.50 to €0.60 per hour and the daily tariff increased by 9.5% from €2.10 to €2.30. Since the decrease in demand is smaller than the increase in price in both cases, the demand for parking space is considered to be inelastic, which can also be seen in the table. The price elasticity for the total years of 2012 through 2014 with respect to 2010-2011 equals -0.47(hourly tariff) and -0.90(daily tariff).

VEEMARKT	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	1.694	1.220	1.714	1.872	2.502	2.020	2.254	292
Average parkers 2012-2014	1.571	1.191	1.528	1.642	2.266	1.834	2.190	339
Parking Tariff 2010-2011	1,90	1,90	1,90	1,90	1,90	1,90	1,90	1,90
Parking Tariff 2012-2014	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Elasticity	-0,82	-0,26	-1,28	-1,47	-1,09	-1,07	-0,30	1,46
Elasticity (absolute)	0,82	0,26	1,28	1,47	1,09	1,07	0,30	1,46

Table 46: Elasticity for Veemarkt (tariff A)

VEEMARKT	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	1.694	1.220	1.714	1.872	2.502	2.020	2.254	292
Average parkers 2012-2014	1.571	1.191	1.528	1.642	2.266	1.834	2.190	339
Parking Tariff 2010-2011	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Parking Tariff 2012-2014	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
Elasticity (hour)	-0,47	-0,15	-0,73	-0,84	-0,62	-0,61	-0,17	0,84
Elasticity (hour) (absolute)	0,47	0,15	0,73	0,84	0,62	0,61	0,17	0,84
Parking Tariff 2010-2011	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
Parking Tariff 2012-2014	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Elasticity (day)	-0,90	-0,29	-1,40	-1,60	-1,19	-1,17	-0,33	1,60
Elasticity (day) (absolute)	0,90	0,29	1,40	1,60	1,19	1,17	0,33	1,60

Table 47: Elasticity for Veemarkt (tariff C)

For the Veemarkt area, looking at the individual days, we observe that all days, except Sundays, faced a decrease in the daily amount of parkers. Mondays and Saturdays are inelastic. Tuesdays, Wednesdays, Thursdays, Fridays and Sundays are considered to be relatively elastic. Sundays show a positive relationship between price and demand, which is contradictory to the theory.

When we look at the areas that have the tariffs A and C combined, we observe that all weekdays faced a decrease in the average daily amount of parkers, except for Sundays. For both areas, there are days that are elastic and days that are inelastic. Overall, Mondays and Saturdays are considered to be inelastic and Wednesdays, Thursdays and Sundays to be relatively elastic.

4.4.7 On-street areas combined

The calculated results for the on-street parking locations combined are displayed in Table 47. As can be observed, the average daily amount of parkers for 2012 through 2014 was smaller than in 2010-2011. In 2010-2011 the average was 7174 parkers per day and in 2012 through 2014 this average was 7087 parkers. From these results, we can conclude that the average amount of parkers decreased by approximately 1.2%. The high tariff increased by 11.4%, from €0.88 to €0.98 per hour, and the low tariff increased by 9.5% from €0.74 to €0.81. The decrease in demand is smaller than the increase in price, therefore demand for parking space for on-street locations is considered to be inelastic, which can also be seen in the table. The price elasticity equals -0.12 for the high tariff and -0.14 for the low tariff.

COMBINED	Total	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average parkers 2010-2011	7.174	5.256	7.008	7.779	10.311	7.784	10.298	1.748
Average parkers 2012-2014	7.087	5.433	6.801	7.446	9.954	7.723	10.334	1.963
Parking Tariff 2010-2011	0,88	0,88	0,88	0,88	0,88	0,88	0,88	0,88
Parking Tariff 2012-2014	0,98	0,98	0,98	0,98	0,98	0,98	0,98	0,98
Elasticity (hour)	-0,12	0,32	-0,30	-0,44	-0,35	-0,08	0,03	1,07
Elasticity (hour) (absolute)	0,12	0,32	0,30	0,44	0,35	0,08	0,03	1,07
Parking Tariff 2010-2011	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74
Parking Tariff 2012-2014	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81
Elasticity (day)	-0,14	0,38	-0,35	-0,52	-0,42	-0,09	0,04	1,27
Elasticity (day) (absolute)	0,14	0,38	0,35	0,52	0,42	0,09	0,04	1,27

Table 48: Elasticity for combined on-street parking locations

Looking at the on-street parking locations combined, we observe that all days faced a decrease in the average daily amount of parkers, except for Mondays (+3.4%), Saturdays (+0.3%) and Sundays (+12.3%). These days show a positive relationship between price and demand, which is contradictory to the theory.

Next to this, all weekdays are inelastic. Fridays and Saturdays are the least elastic, with elasticities of respectively -0.09 and 0.04. Wednesdays are the least inelastic with an elasticity of -0.52.

Section 5: Discussion and Conclusion

This final section of this study will cover the main results of the analysis. The most important findings will be presented and discussed. For some outcomes, possible explanations will be given, with the help of demographic data and factors mentioned in Section 2.3. The discussion is followed by a general conclusion on the price elasticity of demand for parking in Hoorn. After that, some limitations of the analysis will be stated, together with recommendations for further research.

5.1 General discussion

In Section 4, the results of the calculations have been presented. Here, the most important findings will be discussed. First of all, Table 48 presents an overview of the total elasticities per location. These results will be discussed first.

	Price elasticity in terms of parking duration	Price elasticity in terms of amount of parkers
Garages		
Jeudje	-1,26	1,35
Schouwburg	-11,36	1,01
Garages combined	-2,96	1,35
On-street areas		
Tariff A:		
Doelenplein	-0,16	-1,30
Kerkplein	-1,04	-0,55
Tariff B:		
Haven Oost	-0,55	0,33
Haven West	-0,98	1,02
Tariff C/E:		
Lambert Meliszweg	0,04 to 0,08	-2,26 to -4,34
RAC Locatie	-1,41 to -2,70	-2,01 to -3,85
Visserseiland	-1,23 to -2,35	-0,24 to -0,45
Tariff D:		
Pelmolenpad	no data available	-2,95
Transferium	no data available	-0,56
Tariff F:		
Westvries	-0,74	-1,40
Tariff A+C:		
Grote Noord	-0,37 to -0,71	-0,35 to -0,67
Veemarkt	-0,54 to -1,03	-0,47 to -0,90
On-street areas combined	-0,82 to -0,97	-0,12 to -0,14

Table 49: Overview of elasticities per location

For some locations, a range of elasticity is given. This is due to the fact that on those locations a tariff based on an hourly and daily rate is paid, or there are two types of tariffs charged.

As it can be observed, the elasticity for the garages is larger than for the on-street locations, both in terms of parking duration and amount of parkers. This means that the sensitivity of demand to a price change is higher for garages. In terms of parking duration, the parking demand for the garages is considered to be elastic. Kobus et al (2013) elaborated on the matter of an on-street parking premium, which may also be present in Hoorn. If a parker is willing to pay an on-street parking premium, his willingness to pay for an on-street parking spot increases, which decreases the elasticity. This means that his demand for on-street parking is less elastic than for garage parking. Therefore, this might be a possible explanation for the higher elasticity of the demand for garage parking in terms of duration. In terms of numbers, a 1 percent price increase, means a 2.96 percent decrease in parking duration for the garages. This means an approximate decrease of 2 percent in income for the municipality of Hoorn.

On the other hand, in terms of the amount of parkers, the elasticity for garages is larger than zero. This is a violation of the law of demand, since one would expect demand to shrink in the event of a price increase. Although this elasticity larger than zero, and therefore increase in demand, is contrary to the theory as mentioned in Section 2.2, there is a possible explanation. The price increase for the garages was relatively small with respect to the price change for the on-street locations. Therefore, there is a possibility of a substitution effect of parkers from the streets to the garages, because the relative price increase is smaller. This would lead to a decrease in the amount of on-street parkers and an increase in the amount of parkers for the garages.

The elasticities for the on-street areas are in line with previous research. The total is considered to be inelastic with elasticities of -0.82 to -0.97 and -0.12 to -0.14 for the parking duration and the amount of parkers respectively. The elasticity for the parking duration is a bit higher than the average value found in the literature of around -0.3 (Vaca & Kuzmyak, 2005). In terms of numbers, a 1 percent price increase means a 0.82 to 0.97 percent decrease for the parking duration. For the amount of parkers, a 1 percent price increase results in a 0.12 to 0.14 percent decrease.

5.2 Discussion per parking location

Now that the total figures for the garages and on-street parking locations have been discussed, a more in-depth view will be taken at the separate locations, starting with the garages.

The first garage in the analysis is Jeudje. The elasticity in terms of parking duration equals -1.26, which can be considered as elastic. When looking at the separate weekdays, Mondays and Sundays

are about three times as large in terms of elasticity as other weekdays and are highly elastic. Tuesdays and Saturdays are considered to be inelastic. All other weekdays have elasticities larger than zero, which goes against the theory. Overall, the demand in terms of parking duration for the Jeudje garage is considered to be elastic, but this is highly dependent on the weekdays, especially Mondays and Sundays. Regarding the amount of parkers, the elasticity is positive: 1.35. This is, as explained earlier not what is expected from the theory. A closer look at the different weekdays learns that Thursdays are the only days with a negative elasticity: -2.14, which is considered as elastic. Overall, it can be concluded that the amount of parkers for the Jeudje garage has increased for every day, except Thursdays.

The second garage is the Schouwburg. In terms of parking duration, it has an elasticity of -11.36 for the total. This is a very outstanding result, since every 1 percent increase in price would lead to an 11.36 percent decrease in duration. In order to explain this, the municipality of Hoorn was contacted, with the question if they had any clue what could cause this. Unfortunately, the policy maker was not able to give a possible explanation. One possible explanation we can come up with is a change in the program of the theater to which the garage belongs, for instance shorter shows/congresses causing people to park shorter. Looking at the individual days, it can be seen that the elasticities for Mondays and Sundays are again (see Jeudje) the largest. Fridays and Saturdays are relatively small, compared to the total with elasticities -3.69 and -3.50 respectively. Overall, there are really large changes in the parking duration for the Schouwburg garage, but there is no tangible indication of what can have caused this. Regarding the amount of parkers, the total elasticity is larger than zero, with an elasticity of 1.01. This is contrary to the literature. Regarding the weekdays, Fridays and the weekend have negative elasticities. Fridays and Saturdays are inelastic, and Sundays are elastic. Overall, it can be concluded that the amount of parkers for the Schouwburg garage has increased for every weekday except Fridays, and the weekend.

For the total of garage parking, in terms of parking duration the elasticity equals -2.96. This means that the demand is considered to be elastic. Looking at the individual days, it can be seen that the elasticities for Mondays and Sundays are the largest, as was also to be seen for Jeudje and Schouwburg. Wednesdays and Fridays are considered to be inelastic. Overall, it can be concluded that the parking duration for the garages is elastic, but dependent on the day. Mondays and Sundays have the most elastic demand. Regarding the amount of parkers, the total elasticity is larger than zero, with an elasticity of 1.35. This is contrary to the literature. Thursday is the only day that has a negative elasticity and is considered to be relatively elastic. Sundays have faced the largest increase in the amount of parkers. Overall, it can be concluded that the amount of parkers for the garages has

increased for every weekday except Thursdays and the largest increase was on Sundays. For the differences between days, there is no clear causation.

Next, the on-street locations will be discussed in order of tariff, starting with tariff A. The streets in this tariff zone are Doelenplein and Kerkplein.

For the Doelenplein area, the elasticity in terms of parking duration equals -0.16, which is inelastic. All individual days are inelastic too, Mondays and Sundays have the lowest elasticities and Wednesdays and Saturday the highest. In terms of the amount of parkers, the Doelenplein area shows more elastic behavior. The elasticity for the total equals -1.30. Thursdays and Sundays are considered to be elastic too, but all other days show inelastic behavior. The lowest elasticities are found for Wednesdays and Saturdays.

The demand in other area in the tariff A zone, Kerkplein, is considered to be unit elastic in terms of parking duration with an elasticity of -1.04. Mondays, Wednesdays, Thursdays and Fridays are considered to be unit elastic too. Tuesdays and Saturdays are more elastic. Sundays show an increase in parking duration, which is contradictory to the theory. In terms of the amount of parkers, the Kerkplein area shows more inelastic behavior. The elasticity for the total equals -0.55. Mondays and Wednesdays are considered to be the most inelastic, and Tuesdays the least. For the weekend the elasticity is larger than zero, this is again not what is expected from the theory.

The two areas in the tariff B zone are Haven Oost and Haven West. For the first area, the demand regarding the parking duration is inelastic, with an elasticity of -0.55. Also the weekdays are inelastic, with the lowest elasticities for Fridays and the highest for Wednesdays. In terms of amount of parkers, the elasticity for Haven Oost equals 0.33, which is larger than zero and not what is expected from the theory. This also holds for all individual days, except Tuesdays and Saturdays, both days are inelastic. Sundays have faced the largest increase in amount of parkers.

For the Haven West area, the demand in terms of parking duration is considered to be unitary elastic, with an elasticity of -0.98. Mondays, Wednesdays, Thursdays and Fridays are more elastic. Saturdays show a positive relation between price and demand, contrary to what is expected from the theory. In terms of amount of parkers, the elasticity for Haven West equals 1.02, which is larger than zero and also not expected from the theory. On Sundays, the increase in demand is the largest.

For both areas in the tariff B zone, the amount of parkers has increased. Despite the fact that this is not what is expected from the theory, there might be a possible explanation. As mentioned in Section 3.1.2, this is a touristic area. According to statistics of the CBS (2014), tourism in the province Noord-Holland has increased. This could have caused the increase in amount of parkers in this area.

The next tariff zone to be discussed is C/E, the first area in this zone is Lambert Meliszweg. For the parking duration, the elasticity of demand is larger than zero, with values 0.04 to 0.08, this is contrary to the theory. Wednesdays, Fridays and Saturdays do have elasticities smaller than zero and are all inelastic. Mondays and Sundays faced the largest increase in duration. In terms of amount of parkers, the demand is elastic, with elasticities -2.26 to -4.34. For Sundays the demand is considered to be inelastic and Thursday's demand is the most elastic.

For the RAC Locatie, the demand in terms of duration and amount of parkers is both elastic. In terms of duration, Fridays and Sundays have the highest elasticity and Wednesdays the lowest. In terms of amount of parkers, Sundays also have the highest elasticity, but Mondays the lowest.

For Visserseiland, the demand in terms of duration is considered to be elastic. Fridays and Sundays have the lowest elasticity and Wednesdays the highest. In terms of amount of parkers, the demand is inelastic. Mondays and Tuesdays have the largest elasticity and are considered to be elastic, whereas Wednesdays and Thursdays are inelastic. The weekend has elasticities larger than zero, so the amount of parkers has increased with the tariff increase, as opposed to what is expected from the theory.

In the tariff D zone, the areas to be discussed are Pelmolenpad and Transferium. For both of those areas, no data was available on duration. Therefore, only results on the amount of parkers will be discussed. For Pelmolenpad the demand is elastic, with an elasticity of -2.95, but for Transferium the demand is inelastic with an elasticity of -0.56. Mondays have the smallest elasticity in the Pelmolenpad area and Wednesdays and Thursdays the largest. Sundays have faced an increase in the amount of parkers, as opposed to what is expected from the theory. The same goes for Transferium, where Sundays also display an elasticity larger than zero. Tuesdays are the least elastic and Saturdays the most elastic days for the Transferium area.

Westvries is the only location where tariff F is to be paid. In terms of duration, the demand is inelastic (-0.74) and in terms of amount of parkers elastic (-1.40). Fridays are the most elastic in terms of duration and Mondays and Tuesdays in terms of amount of parkers. Regarding the amount of parkers, Fridays and Saturdays show the smallest decreases.

The final two areas to be discussed are areas where two different tariffs are paid, both A and C. The first area that will be discussed in Grote Noord, which has a inelastic demand both in terms of parking duration and the amount of parkers. In terms of duration, Mondays and Thursdays are the most inelastic. When it comes to the amount of parkers, Sundays show a positive relationship between price and demand. This is again not as expected from the theory.

For the Veemarkt area, the demand is inelastic or unit elastic in terms of duration and inelastic in terms of amount of parkers. Again elasticity is dependent on the weekday for both duration and amount of parkers. For the amount of parkers, the elasticity on Sundays is positive, meaning a violation of the law of demand.

For the total of on-street parking, in terms of parking duration the elasticity equals -0.82 to -0.97. This means that the demand is considered to be inelastic. Looking at the individual days, it can be seen that the elasticities for Saturdays and Sundays are the largest and are the only days that can be considered as elastic. Regarding the amount of parkers, the total elasticity equals -0.12 to -0.14, which is considered as inelastic. Mondays, Saturdays and Sundays have faced an increase in the amount of parkers. This is contrary to the literature. One possible explanation for the increasing amount of parkers is the fact that CBS (2014) found that income, tourism and retail in Noord Holland have increased. This might influence the shopping behavior of people in a positive way, or result in more people who visit Hoorn for a day in the weekend. Subsequently, this could increase the amount of parking visitors in the weekend.

5.3 Conclusion

After the discussion of the most important findings, a general conclusion can be formulated and the research questions can be answered.

The findings of this thesis are generally in line with the results of previous scholars on the topic. Overall, one could say that the elasticity of demand for the on-street parking, both in terms of duration and the amount of parkers is inelastic. This is in line with various studies like Zhang (2014) and Hoss (2014).

Furthermore, there is a slight clue suggesting an on-street parking premium as found by Kobus et al (2013), since the elasticities for on-street locations are on average lower than those for the garages.

In line with the research of Pierce and Shoup (2013), high dependence on weekdays is found. This highlights the intertemporal variance of parking demand.

Some elasticities larger than zero have been found, this is of course a violation of the law of demand, but several explanations have been given. For instance the possible substitution from on-street parking to garage parking, or the increased tourism, income and retail in the province of Noord-Holland.

Also, some (highly) elastic results were obtained, but this was only on specific weekdays. This can again be accounted for by the intertemporal variance of the demand for parking, as found by Kelly and Clinch (2009) and Pierce and Shoup (2013).

In the section Introduction, two research questions have been presented:

1. *What is the effect of tariff changes on the parking behavior in Hoorn?*
2. *How can changes in parking behavior be explained?*

The answer to the first question would be that the parking behavior of parkers in Hoorn is not really affected by the tariff change for the on-street locations. For the garage parkers, the influence is slightly greater and a percentage increase in price, results in a larger percentage decrease in demand.

The second question can only be answered in the form of possible influences. For instance, we observed that the price elasticity of demand for the Schouwburg garage was substantial. A possible explanation for this matter was that the program of the associated theatre had changed, but this could not be stated with any certainty. Other possible explanations for changes in parking behavior, next to the tariff change, are the increases in the amount of jobs, retail, population, tourism and income in Noord-Holland. Data on Hoorn itself was not available and also the municipality did not have any possible explanations on the obtained results.

In the section Data and Methodology the following hypotheses were stated, which have been researched:

H_o: *When the price increases, the average duration of an individual parking transaction will decrease*

H_o: *When the price increases, the average amount of daily parkers will decrease*

As can be derived from the above mentioned results and discussion, both of the hypotheses cannot be rejected. We have found decreases in the average duration of an individual parking duration for both on-street locations and garages.

For both on-street parking locations and garages, we have seen decreases and increases in the amount of daily parkers, therefore the hypotheses cannot be rejected.

5.4 Policy recommendation

From the conclusions stated in the previous section, the most important finding is that the demand for on-street parking in Hoorn is inelastic. Therefore, the city should not be afraid to increase the parking tariff. For the parking garages, demand is found to be more elastic. For this reason, a price increase is not recommended for the garages, since it decreases demand more than it increases the price, which can lead to a loss of income.

Of course, these results cannot be generalized for all cities, but policy makers of other municipalities can learn from the case of Hoorn.

5.5 Limitations

There are some limitations to this study. First of all, the data is on a daily basis and there is no exact data on individual transactions. Due to this shortcoming, the time dependence between periods of the day could not be tested, while this is a very interesting subject.

Secondly, there has been a problem regarding the payment system in the garages. Frequent visitors had found a way to avoid payments, so this data might be biased. It was impossible to correct for this matter, because it is unknown when this problem started and ended exactly.

Thirdly, there is no time registration system on the locations Pelmolenpad and Transferium. An analysis of the price elasticity of demand regarding the parking duration was therefore not possible. This problem might not be that substantial, since parking at these locations is for 24 hours at a one-off fee. One would not expect people to park shorter or longer as a result of a price increase, because parking for a longer time does not increase costs.

The fourth and biggest limitation is the fact that the municipality of Hoorn does not have any available data on demographics for the city. Also, they have no clue about the status of their parking locations. This made the explanation of the results of this study more difficult.

5.6 Recommendations for further research

In order to extend this study and solve some of the limitations, some implementations and changes can be made. First of all, data on individual transactions could be used. As mentioned before, it would be possible to research the time dependence on an hourly basis.

Secondly, the data could be on a larger scale, for instance on the whole province of Noord-Holland. This would create the possibility of generalizing the outcomes of the research. Next, it would also be interesting to study the effect of multiple tariff changes.

Another recent and interesting topic to investigate is the effect of mobile parking on the elasticity of parking demand. In this study it was not possible, since the introduction of mobile parking was in the same year as the tariff change.

Finally, the link with external factors could be tested in more detail. By using data on the municipality of Hoorn itself, instead of data on Noord-Holland, for example.

This final recommendation brings us to the final statement of this study. It is very important for municipalities and their policy makers to conduct researches like this. What we have noticed, is that the municipality of Hoorn has no insight in the status of their current parking behavior. Also, they do not have any data on retail, tourism, income and jobs on their own city. In order to manage a proper parking system, it is highly important to know the figures on, and behavior of, the people who park in your city. Therefore, our advice would be to conduct some extensive studies on parking and its (possible) influencing factors, in order to maintain or improve the parking system.

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