

# **Articles on Parking Policy**

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# **Articles on Parking Policy**

## **Proefschrift**

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# Preface

I think my interest in transport started when I was a teenager; at that time, I used to buy every month a magazine about cars, called *Quattroruote*, reading every single page. Later, during my degree in Economics at Ca'Foscari University of Venice, I chose my specialization (*Economia Politica*) just because it was the only one that allowed me to follow a course called *Transport Economics*. I attended that course when it was given for the first time and we were only seven students taking it. Later on, at Ca'Foscari I wrote my master thesis on intermodality in the Veneto Region becoming familiar with, at that time, a new concept: parking the car close to a regional train station and continuing the trip by train. A year later I studied urban management at Erasmus University Rotterdam and I graduated writing a thesis on the use of Park and Ride facilities.

Just before my graduation I was offered a part-time position as course-coordinator at the department of Regional, Port and Transport Economics (RHV) of the Erasmus University Rotterdam. I accepted it because I thought one day I could have become a researcher. After 15 years I am still working there and hopefully I will continue at least for the next 15 years. For this, I will always be grateful to Marco van Hoek who thought having an Italian assistant was a good idea.

After a few years at Erasmus it was quite clear to me that I wanted to write a PhD on parking policy because I was (and still am) convinced that parking is an important aspect of urban mobility. After a period of initial struggle, I got in touch with Bert van Wee at TU Delft. I was very relieved when he accepted me as one of his external PhD candidates. Bert, I would like to thank you for all your support during these years. Not only because you made me a better researcher, but because you encouraged me even when I thought I was not going to make it. I hope that I will be able to inspire and guide my students as much as you did with me.

My sincere gratitude also to all members of the PhD committee for their valuable comments and to the staff of the Graduate School of TU Delft for helping finalizing the PhD process. Of course, I would also like to thank the co-authors of the papers that form this dissertation: besides Bert, Tom Rye for adding his large knowledge on parking policy to complete the first paper. Jordy van Meerkerk, the typical example of when the student is better than the teacher and my colleague Martijn Streng for helping me with the case of The Hague.

I would like to thank all my present and past colleagues at RHV. They have contributed to a wonderful working environment. I hope this will continue for many years. A very special thanks to Peter de Langen, who probably gave me the most important advice for my career: “Gewoon doen!” (“Just do it!”).

Besides my colleagues I want to thank all the students I got to know in these years. For some strange reason I succeeded in convincing many of them to write a thesis on parking. They all played an important role in developing the knowledge I have now. Some did amazing research on parking. Honestly, I should share my PhD title with them.

I also would like to thank the many parking professionals, both within and outside the Netherlands, with whom I have been in contact during the years because they provided me with plenty of knowledge, continuous inspiration and helped me to keep my research focused on the “real” problems. They are too many to mention and surely I might forget someone: thanks to all of you!

There is also another person that deserves to be mentioned separately, Jan van der Borg. Jan has been my thesis supervisor both in Venice and Rotterdam. Because of him I met my wife and I became a researcher and a lecturer. Both events have been a continuous source of happiness for me.

Many thanks also to all my Italian friends: Mirco, Menga, Stefano, Lele, Mirko, Cemb, Tano, Angela, Mariangela, and Francesca. I left Italy more than 15 years ago but I have not been homesick for one single day. Thanks to such strong friendship I feel home every time I am back.

Next my family: I thank my parents for their love and patience when they raised me, and for the values and principles they taught me. I hope I will be able to give my children at least half of what they gave me. And my brother because he practically taught me everything I know: from tying my shoes to adjusting the hot water in the camping shower, from using a computer to riding a car. If it wasn't for him, I would probably still be trying to pass the first year math course at Ca'Foscari.

Finally, I want to thank my children for making me more efficient in my job, and happier in my life. And my wife Liesbeth. Imagine telling people that your husband is doing research on parking, and having to do this for more than 10 years. Now you probably get the picture. Lies, thanks for loving and supporting me.

Giuliano Mingardo  
Delft, October 2016

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# 1 Introduction

## 1.1 Background

Since the sixties the car has been the dominant mode of transport for passengers in most (if not all) OECD countries. In Europe, for example, the share of car passenger travel in the modal split remains well above 70% (EEA, 2014). Despite being built to move people, a car spends on average more than 95% of its existence parked (Shoup, 2005; Bates, 2014). Simply these two facts – that cars have a dominant presence in our society and that they spend most of their time parked somewhere – should be enough to seriously consider parking as a topic of both academic and societal interest. But there are other reasons.

First, parking plays an important role in the decision on whether to possess and/or to use the car. The availability and the quantity of parking at residential locations have a significant relationship with car possession (Guo, 2013). The availability and price of a parking spot at destination also have a significant influence on the use of the car to go to work, to school or for other activities (Shoup 2005; Stead and Marshall 2001; Warffemius 2015).

Second, parking takes (a lot of) space. Typically, a parking space takes around 15 square meters of land. In 2012 there were more than 240 million registered passenger cars in Europe<sup>1</sup>. Even if there is not scientific evidence for that, it is believed that for each car at least 3 parking spaces are necessary: one at home and two at other destinations (Shoup, 2014). We might estimate that approximately 10,800 square kilometers of – mainly urban – land are dedicated to parking in Europe. This is approximately one third of the Netherlands or four times Luxembourg.

A third reason why parking might be an interest object of study is because it is a very costly infrastructure to provide. Average construction costs for one parking space might vary between a few thousand euro for on-street out-of-town locations and more than 100,000 euro for off-street underground location downtown<sup>2</sup>. Nowadays it is relatively normal to invest tens of millions of euros in the construction of a parking garage. Knowing that there are more parking spaces than cars means that this costly infrastructure is very often severely

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<sup>1</sup> Information retrieved from the official website of Eurostat (<http://ec.europa.eu/eurostat/web/main/home>) accessed on October, 28 2015.

<sup>2</sup> Information retrieved from the official website of NRC (<http://www.verkeersnet.nl/1727/ondergrondse-paarkeerplaats-kost-halve-ton/>) accessed on November, 17 2015.

underutilized. For example, in 2014 the average number of short-stay parking transactions per parking space in the garages owned by the municipality of Rotterdam ranged between 0.1 to 0.9 (Spark, 2015). A ratio of 0.5 means that on average there is one car a day parking for each two parking spaces. This means that half of the parking capacity is not used at all for the whole day. This brings us to the paradox that we normally spend a lot of money for cars that pass most of their time parked (= not used) and even more money to build parking capacity that is most of the time not used.

Finally, income related to parking can be a major source of own income for many local authorities. For example, in the Netherlands local municipalities get most of their revenues from the central government; own income sources represent just a minor part of the total revenues (Ministerie van Binnenlandse Zaken, 2005). Among these, parking revenues play an important role. In 2009 the city of Amsterdam has collected more than €130m in parking revenues, almost 25% of the city's own source of income<sup>3</sup>. In order to get parking revenues, cities must attract car drivers. This might be in contrast with the general aim of reducing car traffic and improve air quality.

## 1.2 The complexity of parking policy

Parking policy is a very complex issue and, consequently, is a very difficult one to deal with as a policy maker. There are mainly three reasons for this.

First, there are plenty of misunderstandings and dilemmas within parking policy. Some of these policy dilemmas might even include possible conflicts of interest for the policy maker. Typical misunderstandings in parking concern the idea that free parking exists, the retailers' credo "no parking, no business" (see chapter 3), or the belief that P&R facilities have only positive effects for the accessibility of an urban areas (see chapter 4). Typical dilemmas that policy makers face are the trade-off between municipal income and traffic congestion, i.e. higher parking revenue means more cars entering the city and vice versa, the choice between stimulating long-term or short-term parking, or between stimulating on-street or off-street parking, or choosing between above ground or underground parking, and between maximum or minimum parking standards (see chapter 2).

Second, despite having multiple effects – i.e. it affects transport, environment, land use, economic and social development and finance – parking falls usually under the transport department of the city. This means that usually the approach to parking is purely a traffic and transportation approach, often led by people with a technical background. This might lead to an important shortcoming in policy making. Scientific research should broaden the knowledge on parking, departing from mostly the transportation and economic literature and embracing also other disciplines such as behavioral science, marketing, communication, management, and IT development.

Third, there is relatively little knowledge available, both in the scientific and in the grey literature. For example, the scientific community has for a long time almost neglected parking compared to other policies that might be used to manage transport demand like road pricing. This despite the fact that there are very few real case examples of road pricing, while parking policies are applied in the vast majority of cities. The implication for policy makers is that

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<sup>3</sup> Information retrieved from the official website of the Dutch Statistical Office: <http://www.cbs.nl/nl-NL/menu/home/default.htm> accessed on October, 28 2015.

they are asked to solve a complex matter but often they don't have the right knowledge to address it.

Accordingly, research on parking is necessary to allow policy makers to have a better understanding on this complex issue.

### 1.3 Knowledge gaps

Though in the last 5-10 years the literature on parking has enormously grown, for policy makers there are still many questions that have not been answered. This might partially be caused by the gaps between academic research and policymaking. For academics not all policy issues are interesting for research and, on the other hand, for policy makers many academic research might be not interesting or simply not accessible and/or too difficult to understand.

By far the largest academic contribution to parking concerns the economics of parking. As recently suggested by Inci (2015), the economic literature has focused mainly on cruising for parking, spatial competition, parking requirements and pricing. Within economics, behavioral theory has mostly been used to study search for parking and the driver's choice for parking options. Also the transport literature has focused on several issues related to parking mainly as part of Transportation Demand Management (TDM) policies, such as Park and Ride, parking at site management (i.e. employers, university campus, airports...) and parking as way to manage urban traffic congestion.

Two main knowledge gaps can be identified in the literature on parking:

1. A general theory explaining the development of parking policy is still missing, especially within a European context. The topical works of Shoup (2005) and Litman (2006) deal with most issues concerning parking policy but they don't explicitly describe its development through time. This kind of description is fundamental for policy makers to understand in which framework they operate. More recently Barter (2010) made an attempt to conceptualize the most important elements of parking policy. However, all of them are mainly based on the North American planning experience. A European version of their work is still missing.
2. The effects of many specific parking policies are not yet known. This kind of knowledge is also very important for policy makers in order to implement the right policy options. For example, policy makers still don't know what are the effects of parking pricing on urban retail areas (Mardsen 2006 and 2014), or the effects of Park and Ride (P&R) on the accessibility of the city (Parkhurst and Meek, 2014), or simply the effects of a tariff change in the behavior of motorists.

### 1.4 Problem statement

Because of the importance (see 1.1) and the complexity of parking policy (see 1.2) it is absolutely imperative for academics try to cover these knowledge gaps. This is relevant for increasing the scientific body of knowledge on parking. In addition, it is relevant for policy, because too often, due to a lack of (scientific) knowledge, wrong policies concerning parking are implemented.

Despite the recent development of a wide variety of scholarly literature on parking, the empirical evidence concerning many policy aspects is still missing. Because an overall understanding of the evolution of parking policy is missing, policy has tended to be mainly reactive and operationally focused. As a consequence, policy makers have often missed the strategic link between parking and the overall urban and transport strategy of the city (Rye and Koglin, 2014). Next, because there is no empirical evidence about the impact of parking for retail, very often the provision of abundant and free parking in retail areas is advocated in order to stimulate local retail (Detailhandel Nederland, 2014; Portas, 2011). Similarly, many cities increase P&R supply in the strong belief that this will improve the accessibility of the city and reduce downtown traffic congestion (Parkhurst and Meek, 2014). Analogously, most cities tend to provide parking for residents either for free or for a fraction of the costs (van Ommeren et al., 2014).

While there are other examples of wrong policies implemented because of lack of knowledge, e.g. in the fields of parking standards and enforcement, this thesis focuses only on the four abovementioned aspects of parking policy.

## 1.5 Aim of this thesis

This thesis aims to reduce the abovementioned knowledge gaps in two ways:

1. By providing a general framework for the development of parking policy in European urban areas (chapter 2).
2. By contributing to the scientific knowledge on the relationship between parking and retail (chapter 3), on the effects of rail-based P&R facilities (chapter 4) and on the use of a residential visitors parking permit system (chapter 5).

The *first* issue regards the general development of parking policy; i.e. how parking policy has evolved in the last decennia. This theme is important for policy makers in order to set and understand the framework in which the policy should be developed. The research question addressed in this part is: “*how does parking policy develop in urban areas?*” This question is answered by discussing the development of parking policy in Europe.

The *second* theme concerns the issue of parking and retail. Here I try to shed some light in the hot societal debate on the importance of parking for the retail sector. By comparing the turnover of 83 shopping areas in the Randstad (the Netherlands) with their parking supply I try to answer the question: “*is parking supply related to the turnover of shopping areas?*”

The *third* aspect this thesis deal with is P&R, a policy option widely used in Europe and the only aspect of parking that has been largely addressed in the literature. This part contributes to the existing knowledge by adding the case of rail-based P&R and discussed deeply their environmental and transport effects. This discussion is important for policy makers because P&R often have negative side effects that should be seriously considered. For the third theme the research question is: “*what are the transport and environmental effects of rail-based P&R?*” For answering this question, I analyze the use of nine P&R facilities in Rotterdam and The Hague.

The *fourth* policy aspect I address in this thesis is the one of residential visitor parking permit – i.e. the possibility for residents living in areas with paid parking to buy a number of parking hours that can be used for their visitors. To the author’s knowledge this is the first scientific

attempt to discuss this particular aspect of residential parking. Despite its uniqueness in the literature the concept of residential visitor parking permit is widely diffused in European cities. I focus on the city of The Hague where residents have questioned the validity of the policy. The main question I try to answer is: “*What are the most important insights in the use of a residential visitor parking permit in the city of The Hague?*”

While the general framework for the development of parking policy in chapter 2 is based on the European planning experience, the empirical contributions of chapters 3 to 5 are solely based on Dutch case studies. Yet most of the outcomes in chapter 3 and 4 are supported by literature<sup>4</sup> based on other European cases. Chapter 5 addresses a completely new topic in the scientific literature.

These four aspects of parking policy are just some of the issues that are relevant for research on parking. Other important issues that are not considered in this thesis are for example: parking standards, parking and mobility management, parking management schemes in companies, enforcement, legislation, marketing and communication, new technology applied to parking.

## 1.6 Practical and societal relevance

Parking is an important and complex issue for cities both in terms of policy making and from a societal point of view. Above I already linked the topic of this PhD thesis to policy making. In this section I further explain the links between parking and different areas of policy making, making clear that for policy-making parking is a key element in six main areas: transport, environment, land-use, economic and social development, and finance:

- *Transport*: parking has been recognized as one of the main sources of traffic congestion in urban areas and it is a key element in managing the demand for car use (Shoup 2005; Litman, 2006);
- *Environment*: being a key element in managing the use of car, parking accordingly plays an important role in terms of green house gasses (GHG) emissions (Davis et al., 2010; Chester et al, 2011)
- *Land-use*: parking utilizes space (lots of!) and space is scarce in urban areas. Parking can have a huge (negative) effect on the shape of cities – Jane Jacobs described parking as an anti-urban form (Jakle and Sculle, 2004) – and on the costs of real estate developments (Ison and Mulley, 2014).
- *Economic Development*: for a long time city planners have believed that parking is necessary in order to sustain economic development in the city, i.e. companies will locate in the city only if they can build a lot of parking; visitors will come to the city (and spend their money there) only if abundant and preferable free parking is provided; people will come to live in the city only if there is enough parking for them. It’s difficult to say where these beliefs are based on because there is hardly any evidence supporting them (Marsden, 2006 and 2014; Tyler et al, 2012).
- *Social Development*: car use has been recognized important for accessibility to work, health, education and other important social activities (Preston and Raje, 2007; Lovett et al., 2002). Accordingly, parking policy might influence these types of accessibility.

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<sup>4</sup> This literature will be adequately discussed in chapters 3 and 4.

- *Finance*: for many cities parking is an important source of public funding (see section 1.1) and, at the same time, it is probably one of the most controversial and emotional forms of taxation for citizens (Kolozsvari and Shoup, 2003).

From a societal point of view parking is an important, and sometimes very delicate, theme for several urban actors:

- For residents parking might be a source of frustration either because they can't find a place for their own car or because the number of cars searching for a parking space or (illegally) parked decreases the quality of life around their homes.
- Visitors of the city might have difficulties in finding a parking space close to their destination and most probably they don't like to pay for it;
- Shop owners blindly believe in the credo "no parking, no business"; they would like local authorities to provide abundant and free parking for everyone.
- Politicians and policy makers have the most difficult task to solve the puzzle because they have to make and implement parking policy.
- Companies are also giving more attention to parking management at site; the combination between raising construction and maintenance costs for parking and increasing attention towards sustainability has led many large companies (re)-thinking about the way their employees travel to work.
- Finally, for parking operators, project developers and investment funds parking is either their core business or an important element of their assets.

## 1.7 Theory

The first paper – Urban Parking Policy (chapter 2)– intends to contribute to theory in the field of urban planning. It is probably one of the first attempts to form a comprehensive theoretical framework for urban parking policy, surely at European level. Up to date, the most comprehensive works on parking are based on the North American planning experience (Jakle and Sculle, 2004; Litman, 2006; Shoup, 2005). The article first conceptualizes the key aspects of parking policy and, next, it proposes a framework to describe the evolution of policy in European cities.

The remaining three papers do not intend to directly contribute to theory forming but are embedded in the theory of urban and transport economics and planning. They contribute to existing literature as following:

- The second paper – *Is parking supply related to turnover of shopping areas?* (chapter 3)– contributes to the debate on the importance of parking for the retail sector. The literature on this topic divides into two groups: those suggesting that parking is important for retail activity and those arguing the opposite. In the first group we find, among others, van de Waerden (1998), Arentze and Timmermans (2001), Feitelson and Rotem (2004), Andreu et al. (2006) and Reimers (2013). To the second group belongs the work of, among others, Sustrans (2003 and 2006), Anselmsson (2006), Teller (2008) and Teller and Reutterer (2008). This paper tries to fill the gap in the literature regarding the relationship between parking and performance – mainly turnover and number of visitors – of shopping areas.
- The third paper – *Transport and Environmental effects of train-based Park and Ride (P&R)* (chapter 4)– differentiates by mainstream literature – among others Parkhurst (1995 and 2000) and Meek et al. (2008; 2009 and 2010) – because it considers train

based P&R facilities rather than bus-based P&R. Additionally it adds a number of new “unintended effects” that were previously not yet observed in literature.

- The fourth paper – *Residential visitors parking permit* (chapter 5)– add to the thin existing literature on residential parking (Guo, 2013 and 2014; van Ommeren et al, 2014) by discussing an entirely new topic, namely the case of visitor parking permits for residents, i.e. the possibility for residents living in areas with paid parking to buy a number of parking hours that can be used for their visitors.

## 1.8 Methodology

This thesis consists of four papers, each using a different methodology. The methodology used in the first paper – *Urban Parking Policy* – is inspired by grounded theory. This method is used to generate theories from both inductive and deductive thinking (Glaser, 1992). First we generated concepts regarding parking policy based on scientific and grey literature and on the authors’ own working experience. Second we discussed these concepts with several experts and academics in the field, mainly but not exclusively from the UK and Netherlands, and modified it if needed. After 10 discussions our theory tended to saturate.

The second paper – *Is parking supply related to turnover of shopping areas?* – has a quantitative approach. We use a multiple regression model to investigate the effect of parking on the turnover of 83 shopping areas in the Netherlands. The dependent variable is the yearly turnover per sales floor surface of the shopping areas included in the analysis. The independent variables are divided in three sets, namely (1) parking variables; (2) physical characteristics of the shopping area and; (3) demographic and economic characteristics of the shopping area. Sets two and three are used as control variables when the direct influence of the parking variables is to be determined.

The third paper – *Transport and Environmental effects of train-based Park and Ride* – makes use of two questionnaire-based users’ surveys and specific field observations at nine rail-based [train, metro and conventional train] P&Rs located in the metropolitan areas of Rotterdam and The Hague in the Netherlands. The questionnaires included a number of questions seeking mainly to collect information about users’ travel behaviour, the perceived quality of the P&R service and users’ reactions to the introduction of a daily parking fee in the P&R site. A total of 738 questionnaires have been collected.

In the fourth paper – *Residential visitors parking permit* – we apply an exploratory case study approach. We combine both a quantitative and qualitative method. The quantitative analysis consists of two parts: (1) a data analysis of the parking transactions related to the residential visitors permit scheme and (2) a survey among the residents that have the permit (N=1,153). The qualitative analysis consists of three focus groups with residents (10 participants each) and it is used to integrate the outcome of the quantitative analysis. The participants were selected among the residents that filled in the survey considering differences in age, gender and district of residence.

## 1.9 Outline of the thesis

The rest of the thesis is organized as follow. Chapters 2 to 5 reproduce the four papers as they have been originally published. Chapter 6 first synthesizes the conclusions of each paper, and

then shortly discuss the implications of the research outcomes both from a scientific and from a policy-making point of view. Finally, I conclude with an Epilogue.

Table 1.1 gives an overview of the papers that form the structure of this thesis with the information about the journal of publication, the co-authors, the research aim, methodology and data.

**Table 1.1: Overview of research papers.**

	Title	Authors	Journal	Research goal	Methods and data
H 2	Urban parking policy in Europe: a conceptualization of past and possible future trends	Giuliano Mingardo, Bert van Wee and Tom Rye	Transportation Research Part A: Policy and Practice	To conceptualize parking policy in Europe To propose a new approach for parking policy	Grounded theory Discussions with experts
H 3	Is parking supply related to turnover of shopping areas? The case of the Netherlands	Giuliano Mingardo and Jordy van Meerkerk	Journal of Retailing and Consumer Services	To understand the influence of parking on retail turnover of shopping areas	Statistical data analysis Data from 83 shopping areas in the Netherlands
H 4	Transport and environmental effects of rail-based Park and Ride: evidence from the Netherlands	Giuliano Mingardo	Journal of Transport Geography	To analyze the transport and environmental effects of rail-based P&R in the Netherlands	Surveys and field observations Descriptive statistics
H 5	Residential visitor parking permit: the case of The Hague	Giuliano Mingardo and Martijn Streng	Submitted <sup>5</sup>	To discuss the use of the residential visitor parking permit in The Hague, the Netherlands	Exploratory case study Qualitative and quantitative analysis

<sup>5</sup> At the moment of writing the paper is under revision.



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## 2 Urban parking policy in Europe: a conceptualization of past and possible future trends<sup>6</sup>

### 2.1 Introduction

In the last two decades parking has increasingly gained importance in urban planning mainly because car ownership and use keep growing while urban space becomes scarcer. The literature on parking has been for a long time dominated by grey literature, such as reports and (non scientific) articles published by professionals working in parking. Scientific publications were relatively scarce until the end of the 1990s. In the words of Ison and Rye (2006, p.445) “whilst there are academic papers in the area ... (parking) is, on the whole, an under-researched area of transport” especially when compared to an area such as road user charging. Although in the last few years several papers on parking have been published an overall theory on parking policy is still lacking (Barter, 2010).

The existing literature on parking – both the scientific and the grey one - is very dispersed with most of the articles, papers and reports focussing on specific aspects of parking and/or on specific empirical findings. Additionally, only a few authors have tried to explore the theoretical aspects of parking as a whole. Arnott (2006) researches optimal parking policies in urban areas, whilst others (Verhoef et al., 1995; Calthrop et al., 2000; Button, 2006) focus on the economic analysis of parking policies as a substitute to road pricing. Next, some authors address the theoretical aspect of parking problems in specific areas such as the Central Business District (Ligocki and Zonn, 1984; Voith, 1997 and 1998) or residential areas (Merriman, 1995). Finally Marsden (2006) reviews the (scarce) evidence base upon which parking policies are based concluding that more research is needed in order to fully understand the impact of parking on urban accessibility and attractiveness.

There are very few examples of comprehensive works on parking, the most important being Jakle and Sculle (2004), Litman (2006), and Shoup (2005). Later, Barter (2010) proposed a three-way categorization for parking policy, going further than Litman and Shoup. All of

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them are mainly based on the North American planning experience. More recently Kodransky and Hermann (2011) have reviewed successful parking policies in European cities. In this paper we describe the development of parking policy in urban areas on the basis of the European parking planning experience of the last decades. More specifically the aim of this paper is twofold:

- a) To conceptualize parking policy in Europe, that is, to propose key aspects of parking policy and a generic description of how it evolves;
- b) To contribute to the discussion on the future of parking policy in European cities, by proposing a new approach for it.

To the authors' knowledge this is one of the few attempts to form a comprehensive conceptualisation of urban parking policy. We build on the previous work on Shoup (2005), Litman (2006), Barter (2010) and EU (2005), but go further by introducing a framework to describe the evolution of parking policy. This conceptualisation should help policy makers to position their cities in the right phase of the development of parking policy and to understand the challenges they will face in the next phase. It also helps researcher to identify the questions that practitioners would like to answer. We focus on the European planning experience, with most examples coming from the UK and the Netherlands because these two countries are generally recognized as some of the most experienced in Europe in terms of parking policy and management.

The methodology used for this paper is inspired by grounded theory, a well-known research methodology in the social science. This method is used to generate theories from both inductive and deductive thinking (Glaser, 1992). We do not claim to fully have applied grounded theory in all its steps, but adopted it as a way of developing a new theory. More specifically we first generated concepts regarding parking policy based on the scientific and the grey literature and on the authors' own working experience. Next we discussed our ideas with several experts and academics in the field, mainly but not exclusively from the UK and Netherlands, and modified it if needed. After around ten such discussions, our theory building reached a relative saturation point; further discussions did not contribute further to theoretical development. Despite the fact that most information presented in the paper is based on the UK and Dutch planning experience, we believe that the conclusions and policy implications are likely to hold for other European cities as well. This is supported by previous research which suggests that European cities follow a similar pattern in parking policy (EU, 2005; Dijk, 2010) and confirmed by the discussions with experts.

The remainder of this paper is organized as follows. In section two we present the conceptual elements of parking policy, while in section three we propose a framework that explains how urban parking policy evolves. Section four suggests a different approach for parking policy. We conclude by discussing some of major challenges that will characterize the future of urban parking and making suggestions for further research.

## **2.2 A conceptualization of parking policies**

In most European countries parking policy is a local policy. Each city and town is usually free to set the objectives of the policy and to select the policy instruments to implement it. National governments usually provide guidelines, mostly on parking requirements (see

section 2.2.1), but rarely interfere in policy making<sup>7</sup>. The main reason for this is the recognition that parking is a local matter and that local authorities will deal with it better than will regional or national government.

In this section we conceptualize parking policies distinguishing three aspects: a) the *key elements* of parking supply; b) the policy *instruments* that can be used to change those elements; c) the *aims* of policy making, or the effects that parking policies should have.

### 2.2.1 Key elements and policy instruments

The key elements of parking supply include:

- The number of parking places by type (i.e. on- and off-street parking);
- The location of parking places by type (e.g. out-of-town Park and Ride facilities, downtown garages ...);

Parking supply is of course mediated depending on who owns and controls it. On-street parking is almost totally owned and mostly controlled by local authorities; off-street parking might be owned by either local authorities or private parties and it's usually controlled either by the local authority or by a private parking operator.

Key policy instruments basically consist of:

- Parking requirements, i.e. the “number of parking spaces that must be supplied at a particular location, which is often mandated in zoning codes or development requirements based on publish standards” (Litman, 2006; p. 272).
- Parking regulations, which typically include free parking, time restrictions, users' restrictions (e.g. parking only for residents, or disabled, or public transport passengers ...) and pricing parking.
- Marketing, i.e. trying to persuade car users to use specific parking locations, such as campaigns to use P&R facilities, or specific payment methods such as paying by mobile phone.
- Information and communication, such as (dynamic) route guidance to (available) parking places, either at the road side (information) or via satnav system (communication).

Parking requirements and regulations are policy instruments that are directly used to influence the key elements of parking supply. Marketing and communication are instruments that do have an impact on parking behaviour but not directly on the two elements presented above.

In addition other policies can also have an impact on parking practice, land-use planning being an example. E.g. the type of houses built can have an impact on parking elements, firstly because specific houses attract specific income groups, and secondly because of possibilities to park cars on own territory. We limit our analysis to the abovementioned key policy instruments only.

#### ***Parking requirements***

*Parking requirements* are also known as parking standards or parking norms. Shoup (1999 and 2005) and Litman (2006) have largely discussed the problems related to parking requirements, the most important being the fact that “... urban planners neglect both the price and the cost of parking when they set parking requirements, and the maximum observed parking demand becomes the minimum required parking supply” (Shoup, 2005: p. 580). Parking standards can be set up by national or local authorities. For example in the

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<sup>7</sup> An exception to this is for example Poland, where the national government has the authority to decide the maximum price for on-street parking tariffs.

Netherlands the parking requirements used by municipalities are usually based on the official standards published by the Platform for transport, infrastructure and public space (CROW, 2012). Parking standards can be used by local authorities as minimum or as maximum. Minimum parking standards are usually used when the local authority wants the project developer of a location to provide enough parking capacity in order to satisfy the demand generated from that specific location. The objective is to prevent that a (new) location, for example an office building, generates parking problems in its vicinity, for example residential areas. On the other side, maximum standards are mostly used in central areas, usually well served by public transport, and are meant to restrict the number of motorists entering the location. In the UK parking standards are set by local authorities. In London the change from minimum to maximum standards first took place in the central area with the Greater London Development Plan in 1976 (Lester, 2013). The 2004 parking reform extended this change for the whole city. Guo and Ren (2013) found that this reform considerably reduced parking supply in residential areas. As suggested by the authors, the London reform was mainly promoted by national guidance: the Planning Policy Guidelines 13 – Transport (DCLG, 2001a) and the Planning Policy Guidelines 3- Housing (DCLG, 2001b).

### ***Parking regulations***

*Parking regulations* are defined as “regulations that control who, when, and how long vehicles may park at a particular location in order to prioritize parking facility use” (Litman, 2006; p. 272) and can be considered as the very heart of parking policy<sup>8</sup>. They typically include time restrictions, users’ restrictions – e.g. parking only for residents or for disabled – and pricing parking. The latter is probably the most powerful and, from a political point of view, controversial tool of parking policy.

In Europe parking regulations have a relatively long history. In the Netherlands pricing parking was introduced in the 60’s and, since then, has been continuously expanding. In the UK the first parking meters were introduced in London in 1958<sup>9</sup> and again on-street parking controls have been continuously increased since then, but with a particular boost after 1991, when local authorities became able to take over parking enforcement from the police; and also between 1999 and 2011 in England when the then Labour government’s wider local transport policy encouraged many local authorities to revisit and strengthen their on- and off-street parking policies and measures.

The underpinnings of parking regulations generally come from economic (welfare) theory. As suggested by Glazer and Niskanen (1992) parking has the characteristics of a private good. It is excludable – it is possible to prevent a class of consumers from consuming parking - and it is rival – only one motorist can use a specific parking space at a specific time. For these reasons economic theory suggests that marginal cost pricing should be applied to parking. Accordingly, the parking fee should equal the marginal cost of providing that specific parking place. Additionally, parking needs space, which is not available for other (urban) functions. Space is a scarce resource and, accordingly, the use of it should be charged. However, the practice shows a quite different picture. Hardly any city applies parking fees that reflect the costs of providing parking (van Ommeren et al, 2011). Several authors have recognized that one of the main sources of inefficiency in urban transport markets is the fact that a large

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<sup>8</sup> Note that in policy instruments literature regulations are often presented as opposed to pricing, but in this case we propose to include pricing in parking regulations policies, because pricing can be seen as a part of overall parking regulations policies, as we will explain later in the paper.

<sup>9</sup> Source: <http://www.telegraph.co.uk/news/features/4029123/Time-runs-out-for-the-parking-meter.html>, accessed in July 2014.



percentage of car drivers park for free or for a price far below the marginal cost (Arnott et al, 1991; Calthrop et al, 2000; Shoup, 1995 and 1997; Small, 1997). The consequence is that parking is largely subsidized or, in the words of Shoup (2005, p.218) “(the) cost of... parking has been shifted into higher prices for everything else”.

### ***Marketing***

Within parking policy marketing is mainly used to promote the efficient use of existing parking infrastructure, or to promote a specific parking facility, i.e. advertisement for specific on and/or off street parking facilities. Sometimes it is coupled with the promotion of sustainable mobility. For example P&R facilities can be promoted to encourage people to not enter the city centre by car. Underutilized parking garages located outside the busiest downtown areas might be promoted to reduce search traffic. Sometimes marketing parking facilities can bring the attractiveness of specific shopping areas under the attention of potential customers. Sometimes the marketing of a shopping centre explicitly includes the attractiveness of parking at that centre.

### ***Information and communication***

Information and communication systems - e.g. real time information on the available number of parking spaces and/or guidance systems – are used to guide people to available parking spaces and avoid unnecessary cruising or driving through busiest roads or areas. These systems range from traditional traffic signs and boarding to the internet, to in-car navigation systems and smart phone apps. The latter can also be used to pay for parking.

#### **2.2.2 Policy aims**

Now that we have discussed the links between instruments and key elements we introduce policy aims to which parking policies can contribute. In European cities parking policy has always been part of the more general urban transport policy. Accordingly it has followed the major trends that have characterized transport policy in the last decades (van Wee and Annema, 2013). From its first appearance in the 60’s till the 80’s parking policy has followed the “predict & provide” principle. This period has witnessed a spectacular increase in welfare and car ownership and, being the negative aspects of car use not considered as an urgent problem, parking policy was mainly used to accommodate the increasing number of urban car users. Parking norms have been constantly revised upwards and the city’s total parking capacity kept growing. In the 90’s there has been a shift in transport policy towards the “command & control” principle. Accordingly local authorities reduced the growth of the total parking capacity and started to better regulate and use the existing one, mainly by means of the price mechanism. Finally, since the early 2000s urban transport policy has focused on the “managing demand” principle and parking has become an integrated part of Transportation Demand Management policies (Litman, 2006; Rye and Ison, 2006).

Reviewing the existing literature and the policy documents of the major cities in the UK and the Netherlands we might say that nowadays parking policy has four main objectives:

1. To contribute to a better accessibility and mobility of the urban area<sup>10</sup>;
2. To contribute to a better quality of life in the city (mainly a better air quality and quality of the living environment);
3. To support the local economy.
4. To raise municipal revenue.

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<sup>10</sup> While in the literature (Levine and Garb, 2002) there is a clear distinction between accessibility and mobility of urban areas, in practice these two terms are often used as synonymous in policy documents.

While objectives one to three are usually explicit, the fourth usually is not. This is because local authorities don't want to associate the idea of paying for a parking space with municipal fund raising. However, since the 2004 Traffic Management Act came into force, English local authorities have been forced by central government to publish an annual report that sets out clearly how much money they raised from the parking operation, and how they spent this money.

## **2.3 Evolution of parking policy**

Despite their unique character, most European cities follow the same pattern when it comes to parking policy (figure 2.1). Within this pattern we distinguish three phases each of them consisting of one or more stages. This section describes these phases and relates them to policy aims and instrument discussed in section two. Table 2.1 provides an overview of the stages and the link between section two and three of the paper.

### **2.3.1 Phase One: The rise of parking regulation**

#### ***Absence of explicit parking measures***

At the very beginning any form of parking regulation is absent. In this first stage both car ownership and car traffic are extremely low, and there is abundant space in the urban area to host cars parked mainly on-street with no necessity to charge for it. Accordingly, parking is not considered as a problem at the city level and no formal policy is made for it. Many cities in UK and the Netherlands were in this stage in the first half of the 20th century. Nowadays this might be the case only in remote villages and smaller towns such as High Bentham in North Yorkshire in England, or Inverary in Argyll in Scotland, where parking demand can be managed sufficiently by piecemeal on-street controls to address very site-specific safety problems, and where on-street parking is otherwise unrestricted.

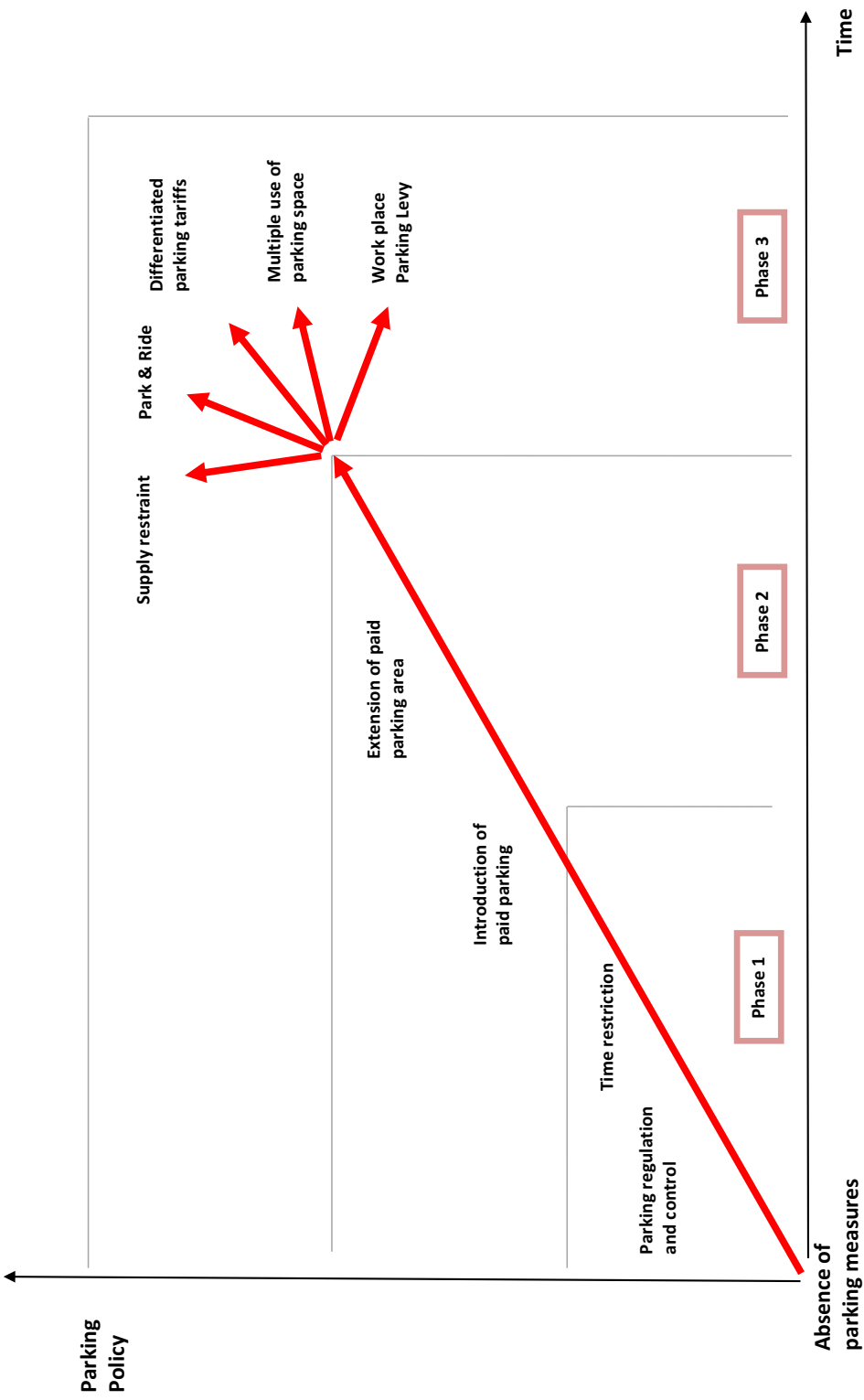


Figure 2.1: the staged development of urban parking policy.

Table 2.1: Relationship between key elements and aims of parking policy and the stages of development.

		Phase 1: The rise of parking regulations			Phase 2: the advent of parking pricing		Phase 3: parking as integral part of TDM strategies
		Absence of parking measures	Parking regulations and control	Time restriction	Introduction of paid parking	Extension of paid parking area	
<b>Aims</b>	<i>Aim(s) of the parking policy</i>	-	To regulate demand and facilitate car use	To regulate demand and maximize the n. of visitors	To regulate demand in order to keep car use and traffic under control		To improve the accessibility, the quality of life and to support the economy of the city
	<i>Major trends in transport policy</i>	“Predict & Provide”			“Command & Control”		“Managing demand”
<b>Tools</b>	<i>Requirements</i>	No parking requirements	The first parking requirements are introduced		Parking requirements are standard for all kinds of new developments		Minimum and maximum parking requirements are introduced
	<i>Regulations</i>	No parking regulations; cars can park everywhere	Parking spaces are clearly marked In some areas it is prohibited to park	Introduction of time restrictions	Introduction of pricing parking in the central area together with residents permits	Extension of the pricing parking area	Further extension of pricing area Use of differentiated parking fees Park & Ride facilities Multiple use of parking facilities Workplace Parking Levies
	<i>Marketing</i>	-	-	-	Some promotion of specific off-street facilities might be done in attempt to increase use of underutilized supply		Promotion of P&R facilities to encourage people not to enter the city center by car Promotion of multiple use of parking facilities
	<i>Information &amp; Communication</i>	-	Simple information about how the parking system works	Simple information about how the parking system works	Simple information about how the parking system works Appearance of the first information systems, such as digital boarding indicating the number of available spaces in off-street facilities		Massive use of IT to guide people to available parking and avoid unnecessary cruising

### ***Basic Parking regulation***

As the level of car ownership and traffic increase, cities start to introduce the first form of parking regulations and control mainly in the city centre and/or in the Central Business District (CBD). The supply of parking starts to be regulated. The main aim of parking policy is to regulate demand in order to facilitate car use. In certain areas parking is prohibited and in other areas parking spaces are clearly marked. Still, most of the parking capacity is on-street and free. In this stage parking standards – usually as minimum – make their first appearance. At present almost all European cities and towns have some basic forms of parking regulation.

### ***Time restrictions***

As pressure on the available parking spaces increases, time restrictions are introduced in the busiest streets or parts of the city (i.e. CBD and main shopping areas). Motorists are allowed to park their cars for a restricted period of time, usually no more than a couple of hours, but still are not asked to pay a price for it. Parking enforcement is introduced in this stage. This kind of policy stimulates short stay parking and is often introduced to maximize the number of visitors (usually shoppers) to the central area.

## **2.3.2 Phase Two: The advent of pricing parking**

### ***Introduction of pricing parking***

Phase two begins with the introduction of paid parking. Rising urban density, welfare and car ownership boost car use in urban areas increasing the parking problem. The demand for parking space clearly exceeds the supply causing congestion – both to enter the city centre and to search for a parking space – and illegal parking. In order to reduce these problems and to regulate demand, parking fees are introduced initially in the city centre. Usually, the areas where first time restriction was introduced are now the first to be regulated through pricing parking.

The very first parking meters were introduced in 1935 in Oklahoma City, in the USA (Shoup, 2005). In the Netherlands it was Schiphol (Amsterdam) airport the first place where parking meters appeared. Amsterdam was the first Dutch city to introduce paid parking, placing 500 parking meters in 1964 (CROW 2012). In 2014 a total of 155 municipalities in the Netherlands had some forms of paid parking, compare to 126 in 1989; paid parking is nowadays active in all cities with more than 100,000 inhabitants and in one third of the cities with a population ranging between 20,000 and 50,000 inhabitants<sup>11</sup>. In England the first parking meter was installed on London's Grosvenor Square in July 1958<sup>12</sup>. However, local authorities have been able to take over the enforcement of on-street parking from the police since the Road Traffic Act was passed in 1991 (the same legislation also required London authorities to make this change). Any authority so doing must introduce some form of charging since the operation is required to be self-financing. In 2000 only 28 English local authorities outside London used these decriminalised powers in at least part of their area, and DfT (2006) reports a “a significant expansion of Decriminalised Parking Enforcement” between 2001 and 2006, which continued into the second half of the same decade, such that by 2010, 265 authorities have used the powers to charge for and enforce parking restrictions in their area<sup>13</sup>.

<sup>11</sup> Source: <http://www.cbs.nl/nl-NL/menu/themas/overheid-politiek/publicaties/artikelen/archief/2014/2014-4043-wm.htm>, accessed in June 2014..

<sup>12</sup> Source: <http://www.telegraph.co.uk/news/features/4029123/Time-runs-out-for-the-parking-meter.html>, accessed in July 2014.

<sup>13</sup> Source: <http://www.telegraph.co.uk/motoring/news/6968607/Motorists-hit-with-ghost-tickets.html>, accessed in June 2014.

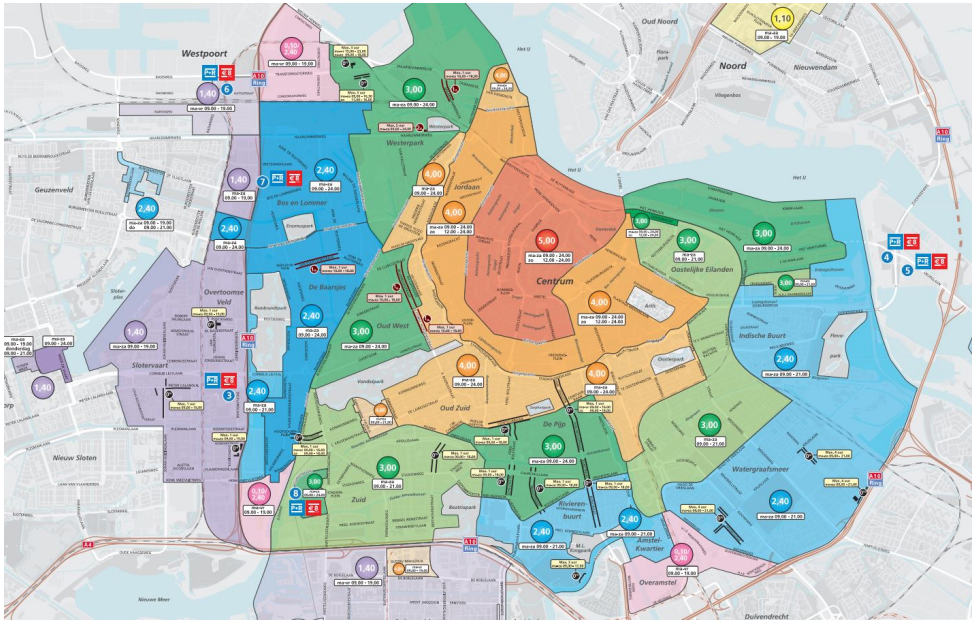
The introduction of paid parking is sometimes accompanied by the introduction of residents' and/or working parking permits. People living and/or working in the areas where pricing parking is active might be entitled to receive a permit to park their car. Initially the parking permits might be free, especially for residents; in a later stage a fee is usually asked for. The enforcement activities increases accordingly; traditionally being a low-skill, labour-intensive activity, parking enforcement often is used to create "social" jobs. Parking standards, in some countries suggested or required by national authorities, are in this stage regularly applied to new development project in the urban areas.

The first purpose-built public off-street parking facilities start to emerge in this stage. The possibility to ask for a parking fee stimulates local authorities and private companies to invest in parking garages.

### ***Extension of the paid parking zone***

As time goes on, the area where pricing parking is active is usually extended. Many drivers tend to park in surrounding (often residential) areas to avoid the payment of a parking fee in the city centre. This increases the parking pressure on these areas (i.e. demand exceeds supply) causing protest especially among residents who might experience difficulties in finding a parking space for their own. As a reaction to the complaints of the residents the local authority usually decides to extend the area of paid parking. This reactive mechanism repeats itself every time the paid parking area attracts more visitors. This phenomenon is known as the "snowball effect" of paid parking or "spill over effects" or, in the words of Ison and Rye (2006, p. 445) as "the boundary effect resulting from the implementation of an area parking policy". Ultimately in the whole inner-city a paid parking regulation system might be present. For example, at the moment of writing this paper (July 2014), in the whole inner-city of Amsterdam is pricing parking active (see figure 2.2). From a situation in the early 1990s where unrestricted on-street parking was available in the inner London Borough of Camden within a 20 minute walk of London's central business district, the local authority has gradually introduced more parking restrictions until today, when on-street parking in its entire area is now controlled (London Borough of Camden 2007). As rule of thumb local authorities introduce (or adjust) price parking when the occupancy rate is above 80/85%.

This stage is also characterized in the Netherlands by the increased use of off-street, often underground, parking facilities. Both local governments and private developers provide additional supply in order to meet the rising demand in the most attractive parts of the city. Increase lack of space, higher land values and a trend towards a better quality of the living environment have caused a shift at first from on-street to off-street parking and, later, from above-ground to underground parking. The UK has witnessed less of this trend – new public off-street parking has been built only in very city centres associated in the main with new retailing, and railway stations. New purpose built off-street parking to accommodate demand from residents whose own homes were originally built without parking is almost unheard of.



**Figure 2.2: pricing parking in the city of Amsterdam in 2014:** the different colours indicate different hourly fees (Source: <http://www.parkerenindestad.nl/amsterdam>, accessed in July 2014).

### 2.3.3 Phase Three: Parking policy as integral part of TDM strategies

Phases one and two are characterized by a reactive parking policy. Policy makers simply introduce specific parking measures in reaction to the rise of a specific problem. The different stages of development in these two phases simply follow each other. Most cities in Europe have followed a similar evolutionary pattern (EU, 2005; Kodransky and Hermann, 2011).

Quite different is the situation in phase three. The increase attention towards quality of life and environmental standards coupled with the increasing costs of providing extra parking capacity – due to scarcity of land and high costs of building (underground) off-street parking – push policy makers towards a better management of parking demand. Parking becomes an integrated part of transport demand management practices (Litman, 2006; Ison and Rye, 2008) and gets a higher rank on the urban political agenda and in the planning process. Large cities consider parking as a major tool to improve accessibility, to stimulate local economy and to achieve a higher quality of life. In this phase a broader vision on parking emerges where parking is more integrated with the general aims of the city in terms of mobility, urban planning and environmental quality. In this phase the shift in policy from “command & control” to “managing demand” (see section 2.2.2) takes place. This is similar to the shift suggested by Litman (2006) from the old to the new Parking Paradigm. The key elements of parking supply and the policy instruments should then change accordingly. We can see typical policy objectives in the example below, showing the stated objectives for parking policy from Edinburgh (UK):

*“The overall objective for the parking strategy is to manage parking to support wider Council economic, environmental and social policies, recognizing the competing demands for space. More detailed objectives are to:*

- i Use parking policy to help to maintain and improve the economic vitality of the city centre and traditional district and local shopping centers, relative to other centers;*
- ii Ensure that parking provision does not encourage commuter car travel, especially to the city centre, and relates to the ease of access by public transport, cycling and walking;*
- iii Minimize the negative impacts of parking on the streetscape, especially in environmentally sensitive areas, and on public and private space in new developments;*
- iv Improve road safety and reduce congestion and pollution;*
- v Facilitate access and movement by mobility impaired people, pedestrians, cyclists, public transport and its users, and motorcyclists;*
- vi Protect and, where possible, enhance residents’ ability to park and load close to their homes;*
- vii Protect and, where possible enhance the parking and loading needs of businesses, tradespeople, carers and visitors;*
- viii Facilitate the operation and expansion of Car Clubs”*

*Taken from City of Edinburgh Council Local Transport Strategy 2007-2012.*

Most cities use the suggested regular parking requirements as guidelines to set their own minimum and maximum requirements (see section 2.2.1). Besides a further extension of the priced areas on-street, some new measures are introduced, the most important being: supply restraint; Park and Ride (P&R) facilities; differentiated parking pricing; the introduction of multiple use of parking space; and workplace parking levies.

### ***Supply restraint***

Probably one of the most strategic policy measures that characterize the third phase is the introduction of reductions or restrictions to parking supply in the city centre and in transit oriented developments (TOD’s). Many large cities in Europe have introduced some form of supply reduction since decades. London started in the seventies with the implementation of the 1976 Greater London Development Plan (Lester, 2013; White, 2008). Copenhagen started reducing parking spaces in the city centre in the sixties; between 1995 and 2000 the Danish capital removed approximately 400 parking spaces, approximately 1% of the total on-street paid parking supply (Kodransky and Hermann, 2011). In the last decade Paris has reduced overall on-street parking supply by 9%, or 14,300 spaces (Kodransky and Hermann, 2011). Restrictions are usually related to lower parking standards for new developments depending on the public transport accessibility. In the literature this is often associated to the concept of TOD’s (Litman, 2006). In Europe there are several examples of this kind of supply restraints; among others in Antwerp (GAPA, 2008) and in Munich (Kodransky and Hermann, 2011). Probably the most famous example of this was the so-called “A-B-C planning policy” introduced in the nineties in the Netherlands, where parking standards for new developments were set by the Ministry of Transport and related to the distance of the new development to the nearest public transport station (Van den Bergh and Verhoef, 2001). Interestingly, this policy – probably the first attempt in Europe to create a national parking policy - has been abolished because local authorities wanted to have more freedom to set their own parking standards. Zurich applies a similar system – i.e. parking standards based on transit accessibility – and since the nineties has introduced a supply cap system (Fellmann et al, 2009). If a parking space is created off-street in the historical inner-city, an on-street parking



space must be removed in order to keep the supply equalized (Kodransky and Hermann, 2011; p. 69).

### ***Park and Ride***

Three types of Park and Ride (P&R) facilities can be distinguished (Mingardo, 2013): remote P&R (close to user's home), peripheral P&R (usually located at the edge of urban areas) and local P&R (along main transport corridors). P&R has been probably one of the aspects of parking that has received the largest attention in the scientific literature: among others Merriman (1998), Parkhurst (2000; 2002), Meek et al (2009; 2010 and 2011) and Mingardo (2013). Most of them suggest that this kind of parking facility might also have some negative effects.

In the Netherlands the first official P&R was introduced in 1979 in Schagen, a small town located north of Amsterdam, as joint initiative of the national railway (NS) and the national car drivers association (ANWB) with the financial support of the Ministry of Transport. Since then, this kind of parking facility developed very quickly. By the end of the eighties more than fifty official P&R were in used; 386 P&R facilities were counted in the country in 2003 (Crow, 2004). Nowadays there are more than 400 P&R functioning in the Netherlands. UK DfT (2006a) found that between 2001 and 2006 English local authorities used government transport funding to build 54 new bus based P&R schemes and to extend 33 existing schemes; and to build 22 new rail based schemes, and extend a further 59. Thus in England also, P&R has become an important plank of local transport policy.

For example Rotterdam has approximately 9,000 spaces in the 32 P&R facilities located around the city, while in the city centre the total (regulated) parking supply on- and off-street is approximately 65,000 places (Stadsregio Rotterdam, 2013). This leads to a ratio of 0.14 P&R space for each parking place in the city centre. A similar ratio (0.13) can be found in Amsterdam: the city has 3,600 P&R spaces and a total of 27,059 regulated parking spaces in the centre (Grooten, 2014).

### ***Differentiated Parking tariffs***

Differentiated parking fees – according to location, time and/or type of vehicle – might be introduced in order to make an efficient use of (scarce) parking capacity. In several cities this is considered as an efficient tool to regulate traffic and/or to apply the “polluter pays” principle in the attempt to reduce pollution caused by motor vehicles. Normally speaking parking fees are highest in the city centre and/or in the CBD and decrease gradually with distance from these central locations. Three major innovations took place in the last decennium in the methodology used to calculate parking tariffs: (1) variable fees according to demand for parking; (2) variable fees according to vehicle's emissions and; (3) real-time parking fees.

1. In the first years after the introduction of paid parking, parking fees were mainly differentiated on the base of the time of day (e.g. at night parking fees are lower than during the day or even absent) and on the day of the week (e.g. during weekends fees might be lower than during the week). In the last decade the pricing scheme has changed in many cities and towns where on-street parking fees might vary several times during the day according to the expected parking demand. While having different prices in different areas of the city is a longstanding practice, the effort to make these variations respond more quickly and precisely to variations in demand can be seen as an innovation. For example Rotterdam was one of the first cities to introduce parking tariffs based on demand in the early 2000's. A minimum fee of

- €0.50 was applied per time window; this varies from 10 minutes (€3 per hour) to 20 minutes (€1.5 per hour) according to the expected parking demand on the street (Gemeente Rotterdam, 2010). When the occupancy rate was above 80% the parking fee was increased; when it was below 60% the fee was reduced. Interestingly the city has decided to stop with this system as for January 2012 (Bos et al, 2013). At present the price differentiation is still in place but the effort to adjust the prices on demand has been abandoned. More recently the city of San Francisco has introduced what is probably the first large scale scheme that applies fees that vary according to actual demand. For a comprehensive description and evaluation of this scheme see Pierce and Shoup (2013). Madrid is following the San Francisco example; from July 2014 the on-street tariff will be related not only to the type of vehicle (see point 2 in this section) but also to the actual demand. Motorist pay 20% and 10% less when the occupancy ratio is, respectively, below 30% and between 30% and 60%; they pay the normal price when the occupancy ration is between 60% and 85%; they pay an additional 10% or 20% when the ratio is, respectively, between 85% and 95% or above 95%<sup>14</sup>.
2. Recently in the Netherland there has been a proposal to modify the national law in order to allow cities to apply different parking fees according to energy label of the vehicles. A recent study (CROW, 2010) suggests that this kind of parking policy might have a positive effect in terms of CO2 emissions but it might be difficult to implement. However in 2011 the parliament decided not to approve such a proposal (Stumpel-Vos and van de Vosse, 2012). A real example can be found in the UK. In London, the borough of Richmond has probably been the first local authority in Europe to introduce parking fees based on the emissions of vehicles: the more pollutant the vehicle is, the higher the fee that has to be paid to park in the borough. This held both for residents and business permits. In 2008 relatively very environmental friendly cars (CO2 emission equal or lower than 100 g/km) could get an annual parking permit for free, while the most polluting cars (CO2 emission equal or larger than 225 g/km) had to pay a higher fee: £300 for resident permits and £1,800 for business permits (Mingardo et al, 2008). The policy became very politically controversial locally and was overturned when the ruling Liberal Democrats lost a local election to the Conservatives. However, councils such as Edinburgh and several other London Boroughs have since introduced similar tariffs related to vehicles' environmental performance. Madrid is the first city in Europe to introduce a similar scheme on a wide area; as for July, 1st 2014 the fee motorists have to pay for on-street parking depends on the engine type and construction year. Electric vehicles can park for free; hybrids have a 20% reduction while heavy polluting vehicles pay 20% extra<sup>15</sup>.
  3. Finally, one of the most important trends in parking tariffs regards the introduction of the so called "real time parking fees", which refers to the application of a parking fee per minute. Normally speaking fees are calculated per hours or by other fixed time periods (e.g. per 30 minutes). Recently this has created some doubts on why the consumer should pay for a larger period of time than what he actually uses. The technological development – namely ticketing machines, sensor technology and payment through mobile phones or in car navigation systems – makes possible to charge drivers for the exact amount of time they park their cars. Spain is the only country in Europe where a national law obliges all off-street private operators to

<sup>14</sup> Source: [http://ccaa.elpais.com/ccaa/2014/04/29/madrid/1398763987\\_835610.html](http://ccaa.elpais.com/ccaa/2014/04/29/madrid/1398763987_835610.html), accessed in July 2014.

<sup>15</sup> Source: [http://ccaa.elpais.com/ccaa/2014/04/29/madrid/1398763987\\_835610.html](http://ccaa.elpais.com/ccaa/2014/04/29/madrid/1398763987_835610.html), accessed in July 2014.

charge drivers per minute since 2006<sup>16</sup>. In the Netherlands, at the moment of writing, only a few off-street parking facilities apply parking fees per minute. However, the use of mobile phones to pay has increased dramatically in the last years: in 2010 approximately one third of all parking transaction in Amsterdam was done through the use of mobile phones<sup>17</sup>; at present (2014) this share is expected to be above 50%. Despite the fact that real-time parking is mainly an operational issue led by new technologies, it does have a strategic component. First, it brings a new important player in the parking sector, namely the service providers – i.e. the company providing the app to pay by phone. At the moment this service providers are different from the parking operators. Second, a large scale implementation of real-time parking fees might lead to a (large) revenue reduction both for public and private operators.

### ***Multiple use of parking facilities***

Increasing construction costs of parking facilities and the trend to store cars underground – to gain additional space above ground for other urban functions – are the main factors explaining the introduction of multiple use of parking facilities. This concept is known in North America as ‘shared parking’; parking spaces are shared by more than one user, allowing for more efficient use of parking facilities<sup>18</sup>. The main idea is to use parking garages and parking lots more intensively. So, for example, the parking lot of a theatre is used during the day by the employees of companies located nearby and in the evenings by the theatre visitors. A downtown garage can be used during the day for the visitors of the city and during the night for the local residents.

Not only off-street parking can be used for different users, but it can also be used and/or combined for different purposes. For example, the noise barriers along the A12 motorway near the Dutch city of Ede are also used as parking garage (see figure 2.3). Another example is the underground parking garage Museumpark in the centre of Rotterdam that can be used, when necessary, as water storage.

Also on-street parking can be used for different users. Copenhagen introduced in 2011 a pilot project with flexible on-street parking: five parking spaces in front of a secondary school are dedicated for bike parking between 7:00am and 5:00pm and for car parking for the remaining period<sup>19</sup> (see figure 2.4).

The trend towards an increasing use of shared parking can be seen as part of a more general trend, namely a shift away from requiring so much private off-street parking towards an emphasis in making better use of existing (public and private) supply. This trend has already been reported by Shoup (2005) when he introduces the concept of providing public parking in lieu of private parking as a way to eliminate (or reduce) off-street parking requirements. The author provides an overview also of number of European examples, namely in United Kingdom and Germany (Shoup, 2005; p. 230).

<sup>16</sup> Source: <http://www.20minutos.es/noticia/242274/0/minutos/parking/lev/>, accessed in July 2014.

<sup>17</sup> Source: <http://www.at5.nl/artikelen/41836/belparkeren-steeds-populairder>, accessed in July 2014.

<sup>18</sup> Source: <http://www.vtpi.org/tdm/tdm89.htm>, accessed in October 2012.

<sup>19</sup> Source: <http://www.cycling-embassy.dk/2011/08/22/experiments-with-flexible-parking-in-copenhagen/>, accessed in December 2013.



**Figure 2.3: the parking garage of the CineMec in Ede is built into the noise barrier for the A12 motorway in the Netherlands**

(source: <http://zakelijk.cinemec.nl/nl/content/4194/bereikbaarheid.html>, accessed in June 2014).



**Figure 2.4: flexible on-street parking in Copenhagen** (source: <http://www.cycling-embassy.dk/2011/08/22/experiments-with-flexible-parking-in-copenhagen/>, accessed in December 2013).

### ***Workplace Parking Levy***

A workplace parking levy (WPL) is a tax on private non-residential parking provided by employers, off-street, for their staff. Local authorities in England and Wales are permitted, under the UK Transport Act (2000), to introduce such a tax, subject to final approval of the scheme by national government. However, to date, only one local authority, the City of Nottingham, has introduced such a scheme, and then only in April 2012 – currently (July 2014) employers with more than 10 staff are required to pay the City Council (municipality)

288GBP (around 350 Euros) per year for each space in use. In England and Wales the lack of other cities that have implemented the measure may be explained by political fears about its possible impacts on economic development; and in other countries in Europe, such a levy is not currently legally permitted.

## 2.4 The need for a strategic approach

The major shift in urban parking policy occurs when a city enters phase three. In phase one and two parking policy has always tended to be rather reactive and rather operationally focused, failing to see parking in a holistic urban (transport) planning context. Urban planners and policy makers, during these phases, simply follow the consecutive steps – i.e. time restriction, pricing parking, and extension of the pricing area - in a rather reactive way. When a specific parking problem occurs, for example spillover effects at the edge of the paid parking area, the corresponding solution is implemented – extension of the pricing area. This approach might work for phases one and two but by the time a city moves to phase three the pressures of parking are such that a more strategic approach is required.

The strategic approach we advocate firstly requires the full integration of parking policy within general urban and transport policy and, secondly, making parking policy part of a broader demand management strategy. In order to achieve this, some of the major shifts that must occur in policy making are the following (see Table 2.2):

- The supply of parking – i.e. the key elements (see section 2.2) – must be adequately inventoried. Currently, most cities lack basic data such as total parking capacity, a clear distinction between private and public parking capacity, and information about the use of parking. For example, in spite of the fact that all transactions made through modern on-street Pay and Display ticketing machines are registered, these data – containing among other information about the number and the length of parking transactions – are rarely used by policy makers. Indeed many policy makers are simply not aware of the fact that these data are available at all. It is very difficult to manage demand (for parking) properly if little is known about (parking) supply. The city of Leiden in the Netherlands (Gemeente Leiden, 2014) and the city of Treviso in Italy (Crosato, 2011) are good examples of cities that collect data about parking transactions and use them to support decision making.
- There is a need to re-think parking requirements in the light of the inadequacy of national guidelines. Both Shoup (1999, 2005 and 2013) and Litman (2006) have criticized the way in which parking requirements are influenced by national guidelines. Not only do they have to be flexible, considering the specific characteristics of each site and activity; parking norms also have to find the right trade-off between the needs of the public authority – principally to prevent spillover effects and undesired car traffic – and the needs of private developers – which are mainly to reduce costs and/or to build attractive properties. Ultimately, the new strategic approach to parking would lead to parking standards defined per area and not, as it is currently the case, per building; be expressed as a range, to take account of local context; and linked to accessibility by other modes. Policy makers and planners should consider the total parking supply in the area before requiring new capacity, and seek ways to allow multiple uses of parking facilities (see section 2.3.3). For example in the city of Utrecht parking requirements are lower when applied in areas with on-street paid parking (Gemeente Utrecht, 2013). Zurich, besides its supply cap system

(see section 2.3.3), applies parking standards for new developments based on the level of public transport accessibility (Kodransky and Hermann, 2011).

- National government should play an active role in encouraging cities to take a more innovative approach to parking policy, both management of existing parking, and construction of new supply; and in highlighting to them the need to place parking policy within a wider strategic transport planning context, such as that of a sustainable urban mobility plan (SUMP; European Commission, 2011). It is interesting to note the role of such guidance from English central government in encouraging cities in England to take action on parking over the first decade of the 21st century (see UK DfT, 2006b and 2007; UK Department for Communities and Local Government, 2012).
- Marketing and communication must play a fundamental role within parking policy. Parking has often a bad image among drivers and retailers (both thinking it should be abundant and for free) and even among politicians (seeing it as a difficult portfolio for which to take responsibility). Often the only communication about parking provided by the local authority is about how the system works – i.e. time restrictions, ticketing machines, permits, etc. Hardly any city communicates why the system is in place – that is, why the user should pay for parking, how parking income is utilized, and so on. The San Francisco parking scheme mentioned earlier is a good example of this: in the words of the authors “... SFpark helps to depoliticize parking by stating a clear principle for setting the prices for curb spaces” (Pierce and Shoup, 2013: p. 69). Another interesting example is provided by the town of Roermond (the Netherlands) that has recently communicated that the extra income generated by the increase in parking fees goes to a so called “mobility fund” which is used to improve the overall accessibility of the city<sup>20</sup>. English municipalities are now required (since 2008) to publish an annual report describing their parking operation, how much money they raised from parking charges and from fines, and what they have done with the money raised; however, how well the municipalities publicise this report is their own decision.
- Finally decision making should be based on knowledge and facts. Information must be carefully collected and analysed before taking (expensive) investment decisions. Data collection and analysis are used in many sectors within transport like railway companies, airlines and car manufactures. Parking has simply become too important and too expensive for public authorities and decision making to be based on anything other than sound knowledge.

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<sup>20</sup> Source: <http://roermond.gezien.nl/nieuws/mobiliteitsfonds-roermond-opgericht.html> accessed in June 2014.

Table 2.2: Comparison of the main approach of phases 1 and 2 with phase 3

Reactive/Operational approach to parking policy (phase 1 and 2)	Strategic/Evidence Based approach to parking policy (phase 3)	Main advantages of phase 3
<p>Parking policy is not seen as an important part of urban policy.</p> <p>Parking policy is mainly reactive, implementing measures only when a problem arises.</p>	<p>Parking policy has a holistic approach and is fully integrated in the urban (transport) planning context.</p> <p>Parking policy is mainly proactive – i.e. it tries to prevent (parking) problems from occurring.</p>	<p>Parking does not work against other policy objectives, i.e. increasing transit or livability in urban areas.</p>
<p>Basic data about parking supply are not available and/or used.</p>	<p>Parking supply is properly inventoried. Data are used to support decision making.</p>	<p>It facilitates TDM strategies and increases the acceptance of parking policy.</p>
<p>Parking requirements are based on national guidelines often applied with little or no flexibility.</p>	<p>Parking requirements are flexible and set in accordance to meet the needs of both public authorities and private developers.</p>	<p>Better investment decisions lead to more efficient use of (scarce) resources.</p>
<p>Marketing and communication are reduced to the minimum – i.e. information on how the system works.</p>	<p>Active communication is used to explain the role of parking in urban areas.</p>	<p>Better investment decisions lead to more efficient use of (scarce) resources.</p>
<p>Decision making very intuitive leading to wrong (expensive) investment decisions.</p>	<p>Decision making is based on data analysis.</p>	<p>Improved understanding of parking policy, better image for parking management.</p>
		<p>Better investment decisions lead to more efficient use of (scarce) resources.</p>

Nowadays, most of cities and towns in Europe have entered (or are entering) the third phase, but there remains a tension between the reactive/operational approach to managing parking, and the more strategic, evidence based approach that we advocate here. This is not least because parking remains managed by parking managers, whose focus is by necessity operational, whilst wider transport strategy and the role of parking within it is more normally dealt with by strategic transport planners, whose focus is less reactive and operational. Communication between the two may not always be regular, or optimal.

## 2.5 Concluding remarks

Although research on parking has substantially increased in the last decade, an overall conceptualisation of the evolution of parking policy is still missing. The most relevant earlier work is probably that of Shoup (2005), Litman (2006) and Barter (2010). In different ways they all suggest a shift away from the conventional “predict & provide” approach to parking policy. Their work is mainly based on the North-American planning experience. This paper has built on their work, focusing on Europe, and tried to go beyond it by conceptualizing parking policy first, and suggesting the ingredients for a new approach to parking thereafter. Parking policy has always tended to be rather reactive and rather operationally focused, not seeing parking in a holistic transport/urban planning context. This approach might be adequate for phase one and two of parking policy but by the time a city moves on to phase three the pressures of parking are such – and not just in city centre areas – that a more strategic approach is required. At this stage, parking policy must become an integral part of general urban and transport policy and a core element of a broader demand management strategy. In order to achieve this, a major shift in the use of parking instruments (section 2.2.1) must occur. The advantages of a strategic approach, compared to a reactive one, include mainly a better and more efficient use of resources – i.e. reduced costs for the provision and management of parking – and the creation of broader acceptance for parking policy.

Considering the future of urban parking we can identify three major challenges that policy makers will face in phase three, namely:

- a) Increasing pressure on the financial aspects of parking policy. The trend towards a larger use of expensive (often underground) off-street facilities, the growing political pressure on parking charges (mainly retailers asking for lower charges) and the increased costs associated with the enlargement and enforcement of the paid parking area on-street can easily lead to a situation where the costs of implementing parking policy rise faster than revenues. For example between 2008 and 2012 many cities and towns in the Netherlands and in England have witnessed a decreased in the income generated by parking fees while the costs of implementing the policy have remain mostly unchanged (Spark, 2013; Moerkamp, 2013; review of Annual Parking Reports in England).
- b) The need to decouple new developments from existing parking requirements. As mentioned in section four, rigid parking standards are not appropriate for managing parking in phase three. National guidelines (on parking standards) are simply not able to reflect adequately the site-specific characteristics of new development. For example a growing number of private companies are using TDM policies and Travel Plans to reduce car dependency among employees and local authorities must consider this when deciding how much parking the company has to provide.
- c) The introduction of parking regulations in residential and suburban locations. While the use of active parking regulation – especially pricing – is (more or less) accepted in



the central areas of at least medium and larger cities, more controversial will be its acceptance in peripheral residential areas, not to mention in suburban municipalities. A constant increase in welfare and other socio-economic changes – for example more women in work, flexible working hours, changing housing composition and increasing number of immigrants – are leading to higher levels of car ownership in all but central cities. When this happens in residential areas built some decades ago – when car ownership was lower – it leads to significant capacity problems, but the patterns of parking in these areas make standard on-street parking management much less financially viable than in inner areas.

Finally we draw some suggestions for further research. Entering phase three means that policy making becomes even more complex. Urban planners and decision makers, as well as private developers, need to take important decisions on how to invest scarce financial resources. Academic research should try to help them with relevant knowledge to support the decision making process. Academics and parking professionals (policy makers, advisors...) have operated for a long time – in phase one and two – in separate fields. The outcome of this is twofold: on the one hand there is little interaction among the two groups; on the other hand there might be a mismatch between the knowledge produced by academics and the knowledge needed by planners and decision makers. To overcome this gap between the two groups we recommend future research to be carried out, at least in part, in close cooperation with practitioners and focus on policy-related issues. Much under-utilized data on parking are stored in hard disks somewhere by local authorities, waiting to be analysed. And practitioners have many questions that they would like answered, but often lack the skills or knowledge to do so. Future research should aim to bridge this gap in order to produce more evidence based, and ultimately, more cost-effective parking policy.

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## 3 Is parking supply related to turnover of shopping areas? The case of the Netherlands<sup>21</sup>

### 3.1 Introduction

When planning for new retail areas policy makers face several spatial issues (Moiseeva and Timmermans, 2010). One of these issues is parking; basically planners must decide the amount of parking that will serve a shopping area and the parking regime that will take place (i.e. paid parking or time restrictions...). Normally speaking, especially among shop owners, retail managers and branch organizations, there is a widespread belief that parking plays a fundamental role in the performance of shopping areas. The dogma “no parking, no business” is often used to describe the retail sector’s point of view. This view has been embraced and emphasised by the parking industry that has seen its business growing spectacularly in recent years. The consequence is that local authorities are often under pressure in order to provide additional parking capacity and/or reduce or freeze parking tariffs in and around shopping areas, even in downtown locations. The idea behind the dogma “no parking, no business” is mostly based on three assumptions. The first is that most customers reach the shopping area by car. Out-of-town shopping centres – provided with abundant and often free parking capacity – are usually used as an example to support this assumption. The second is that drivers are the best customers because they spend more money than customers coming with other transport modes. This is based on the idea that customers by car can carry (and thus buy) larger quantities or larger products. The third is that car drivers’ choices where to go shopping is strongly influenced by the availability of parking.

The literature on the relationship between parking and retail divides into two groups: those suggesting that parking is important for retail activity and those arguing the opposite. In the first group Van der Waerden et al. (1998) suggest that “the consumer choice of supermarkets is influenced by store characteristics and by parking characteristics” (p. 314). Still and Simmonds (2000) report the retailers’ perception that the provision of parking facilities for shoppers is positively related to the vitality of retail centres. However the authors state that shoppers might be less constrained in where they do their shopping activities. Arentze and Timmermans (2001), focusing on models for multipurpose shopping behaviour, consider

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parking as a factor enhancing shopping convenience. This is indirectly suggested also by Feitelson and Rotem (2004) discussing the effects of taxing surface parking. Also Andreu et al. (2006) suggest that parking plays a positive role in the consumer's perception of a retail environment. A study for the RAC Foundation (2006) in the UK reveals that 64% of the shopping trips are made by car. Moreover 40% of the drivers find parking "too expensive and too difficult to find" (RAC Foundation, 2006; p. 13). It is believed that customers will choose other shopping areas if the accessibility by car is restricted due to reduce parking capacity and/or increased tariffs.

The second group suggests evidence that retailers have a wrong perception about the modal split of their customers and that they usually overestimate the importance of car use for shopping. For example in Graz (Austria) research shows that shop owners think that 58% of their customers use the car to reach the shop, while in reality it is only 32% (Sustrans 2003). A similar result has been found in Bristol (UK) in a survey among 126 retailers and 840 customers (Sustrans 2006); retailers think that 41% of the customers come by car while only 22% of the interviewed customers actually used the car to reach the shopping area. Christiaens (2000) performed a survey among shoppers in the city centre of Breda, The Netherlands, and found that a cyclist on average spends more per week than a car driver. Drivers spend more per visit but their shopping frequency is lower. Similar results in The Netherlands have been found in Utrecht (Verhoek, 2000) and Rotterdam (Mingardo, 2009). Additionally, a survey among the customers of a local supermarket in the Dutch city of Leiden shows that there is no relationship between transport modes and average expenditure per person per week (Mingardo et al., 2009). Haringsma (2008) found that the level of parking tariffs has almost no influence on the visitors' choice for a shopping centre. Quality of shops and atmosphere of the shopping area are considered more important to attract customers than parking tariffs. Teller (2008), analysing the relative importance of nine agglomeration format characteristics on attractiveness of shopping malls and shopping streets, found that retail tenant mix and atmosphere has the highest relative importance. He concludes also that parking does not seem "to provide potential to change the attractiveness of the investigated agglomeration factors" (Teller, 2008; p. 397). Similarly, Anselmsson (2006) found that selection and atmosphere are the two most important sources of customer satisfaction for shopping malls in Sweden. Convenience, which includes opening hours, parking, ease-of-movement and ability to find one's location in the mall, was listed only as third source of satisfaction. Finally Teller and Reutterer (2008), analysing more than 2,000 on-site interviews of customers of both an inner city shopping street and a competing peripheral shopping mall in Vienna (Austria), conclude that tenant mix and the atmosphere, unlike parking and accessibility, have a major impact on perceived attractiveness of the retail area. However the authors also conducted a parallel survey where (potential) customers were interviewed at home. In this case parking and accessibility "affected all dimensions of attractiveness to a considerably higher degree" (p. 138).

To the authors' knowledge there is a gap in the literature regarding the relationship between parking and performance – mainly turnover and number of visitors – of shopping areas. In particular there are no statistical analyses of the importance of parking for shopping areas. The aim of this paper is to test whether the general dogma of the retail sector "no parking, no business" is correct. The authors use a set of different data on 80 major shopping areas in The Netherlands to discuss, by means of a multiple (loglinear) regression analysis, the influence of parking on retail turnover. The central research question of this paper is: *is parking supply related to turnover of shopping areas?*



The remaining part of the paper is structured as follow. Section Two describes the datasets and the methodology we use for this study. Section Three presents the results. More specifically we perform the multiple (loglinear) regression analysis in order to identify the influence of parking on the turnover of shopping areas. Section Four concludes discussing the findings of the statistical analysis and the implications for policy.

## 3.2 Methodology

In order to investigate the influence of the parking on the turnover of shopping areas we use a multiple regression model. The dependent variable is the yearly *turnover per sales floor surface (SFS) m<sup>2</sup>* of the shopping areas included in the analysis. Three sets of independent variables are identified: 1) parking variables; 2) physical characteristics of the shopping area and; 3) demographic and economic characteristics of the shopping area. Sets two and three are used as control variables when the direct influence of the parking variables is to be determined. For each shopping area the variables parking capacity and turnover are divided by the total SFS, producing the variables ‘parking capacity per SFS m<sup>2</sup>’ and ‘turnover per SFS m<sup>2</sup>’. This is done to avoid that the size of the shopping areas might act as a disturbing factor. The first section of this methodology deals with the description of the datasets whilst the second section presents multiple regression model used for the analysis.

### 3.2.1 The database

The *yearly turnover* of the shopping areas object of this study is obtained from different regional surveys performed by consultant Goudappel Coffeng (2004). The methodology used to collect this kind of information is based on telephone-based consumer surveys and on data about shoppers’ expenditure from the National Board for Retail Trade (‘Hoofdbedrijfschap Detailhandel’ in Dutch) and from the National Statistical Bureau of the Netherlands (CBS).

Three sets of independent variables are used:

Set 1: the *parking variables* include:

- The *parking capacity* of the shopping area, that is the total number of parking spaces available in the shopping area;
- The *average first hour parking tariff* in the shopping area, that is the weighted average between on-street and off-street first hour parking tariffs;
- The *percentage on-street parking* on the total parking capacity.

Set 2: the physical characteristics of the shopping areas include:

- The sales floor surface (SFS);
- The percentage of shops selling daily products;
- The percentage of the shopping area SFS designated for daily products;

Set 3: the demographic and economic characteristics of the surrounding areas include:

- The *population density* in the area surrounding the shopping area (number of inhabitants per km<sup>2</sup>);
- The *degree of urbanization* of the area surrounding the shopping area (number of registered addresses per km<sup>2</sup>);
- The *car density* of the area surrounding the shopping area (number of registered cars per km<sup>2</sup>);
- The *average income* of the inhabitants of the area surrounding the shopping area;

Both the parking variables and the physical characteristics of the shopping areas are collected from the “Parkeermonitor 2005-2006®” developed by consultant Goudappel Coffeng (2006). The “Parkeermonitor” involves periodic data collection about parking-related criteria relating to the major shopping areas in the Netherlands. The data concern 391 shopping areas in the country and are collected from different sources. Parking variables consider an area covering a radius of 300 m from the shopping area. Set 3 data are collected from the Statline Database of the CBS<sup>22</sup>; these data are available at district and neighbourhood level. We used GIS software to harmonize the spatial scale of datasets 1 and 2 (Parkeermonitor) with data from set 3 (CBS). The majority of the shopping areas overlap two or more CBS districts; accordingly we calculated a weighted average of the demographic and economic variables of the districts covered by each shopping area, based on the percentages of geographical overlapping.

### 3.2.2 Data harmonization

Data about the turnover of the shopping areas were available only for 2004, whilst the data selected about the independent variables referred to the year 2005. This discrepancy is due to the fact that data regarding parking variables and the shopping areas are available only for the year 2002 (Parkeermonitor® 2002/03) or 2005 (Parkeermonitor® 2005/06). We used the 2005 Parkeermonitor® data, mainly for two reasons. First, the 2005/06 edition of the Parkeermonitor® includes more detailed and accurate information than the 2002/3 edition. Second, there are no large differences in household expenditure for typical products sold in shopping areas in the Netherlands between 2004 and 2005. In this period the household expenditures index of the Netherlands for goods, food and durable goods varies respectively from 108.1 to 110.0, from 114.5 to 113.9 and from 102.6 to 102.8 (Index 2000 = 100, source [www.cbs.nl](http://www.cbs.nl)). Accordingly the independent variables should not be influenced by this discrepancy.

The shopping areas included in this study are classified based on their function, i.e. with respect to the region they serve. This classification is based on the number of shops located in the shopping area. The following four functional types are distinguished (Locatus, 2007):

- City centres (N=8): shopping areas with more than 400 shops.
- Regional centres (N=40): between 100 and 400 shops.
- Core centres (N=3): up to 100 shops.
- District centres (N=29): between 50 and 100 shops.

The database of the Parkeermonitor® 2005/06 contains data about almost 400 shopping areas in the country. However, in order to investigate the relationship between parking and turnover, we must limit the analysis to the shopping areas for which the turnover is known. This restricts the analysis to 80 shopping areas. In the remainder of the paper different numbers of observations are included in the empirical analyses. These numbers depend on the data available for the different variables used in the analysis. An overview of the observations is given in table A 3.1 in the appendix.

### 3.2.3 Research methodology

In order to investigate the influence of parking on the turnover of shopping areas we use a multiple regression model. The possible presence of multicollinearity among the explanatory variables is evaluated by using the Variance Inflation Factor (VIF) with a critical level of five.

<sup>22</sup> All data are available online at [www.cbs.nl](http://www.cbs.nl).

A high level of multicollinearity might affect calculations regarding the individual predictors of the model. The critical value of five is a ‘rule of thumb’ (O’Brien, 2007).

To deal with the multicollinearity problem, we use linear regression in which the control variables are replaced by factor scores, based on a Principal Component Analysis (PCA). A PCA is applied only to the control variables (sets 2 and 3 of the independent variables) such that the influence of each parking variable can still be examined individually when applying the regression analysis. As PCA seeks to maximize variance, it is highly sensitive for scale differences and variance differences across the original variables. Accordingly the correlation matrix, based on the standardized control variables, is used as input for the PCA (Table 3.1). Usually, those components which have an eigenvalue greater than unity are retained for further analysis. However, we wanted the remaining components to be still interpretable on the base of combinations of the original variables and the PCA solution to capture the variances of each original variable as far as possible. Ultimately a trade-off between dimension reduction and interpretability is made.

In order to interpret the principal component solution, we look at the principal component loadings. To simplify the structure of the loading matrix a Varimax rotation method is used. Ultimately the new variables, replacing the original control variables, are obtained by multiplying each original variable with the component scores of each component of the PCA solution. The new variables - the factor scores - are used in the multiple regression model. To make a reliable comparison among the different shopping areas included in the analysis, turnover and parking capacity are corrected for the overall size of the shopping areas. Accordingly we use the variables ‘parking capacity per SFS m<sup>2</sup>’ and ‘turnover per SFS m<sup>2</sup>’.

**Table 3.1: Correlation matrix used as input for the PCA (N=157)**

Variables	SFS	Perc. daily sp	Perc. daily sfs	Urban degree	Pop. density	Car density	Income
SFS	1						
Perc. daily sp	0,53**	1					
Perc. daily sfs	0,62**	0,86**	1				
Urban degree	0,33**	-0,08	0,1	1			
Pop. density	-0,06	0,59**	0,38**	-0,62**	1		
Car density	-0,03	0,40**	0,25**	-0,66**	0,90**	1	
Income	0,25**	-0,54**	-0,38**	0,09	-0,50**	-0,26**	1

The significant correlations are marked with \*\* ( $p < 0.01$ ).

### 3.2.4 The model

Let  $\ln Y_i$ , be the natural logarithm of the ‘turnover per SFS m<sup>2</sup>’ of shopping area  $i$ . The turnover of the 80 shopping areas in the sample are modelled by the following multiple loglinear regression model (equation 3),

$$\ln Y_i = \beta_{0,i} + X_i' \beta_{\square} + \varepsilon_i, \quad i = 1, \dots, I \quad (3)$$

where,  $\beta_{0,i}$  denotes the intercept term,  $X_i$  a  $K \times 1$  dimensional vector containing the  $K$  explanatory variables with respect to shopping area  $i$ , and where  $\beta_i = (\beta_{1,i} \dots \beta_{k,i})'$  with  $\beta_{k,i}$  the parameter measuring the effect of the  $k$ -th explanatory variable on the sales of item  $i$ .

The vector of explanatory variables contains the log-transformed parking variables – the parking capacity per SFS  $m^2$ , the percentage of on street parking capacity and the weighted average first hour parking tariff – and the factor scores based on the PCA. Finally, the error term  $\varepsilon_i$  is assumed to be normally independently and identically distributed, that is  $\varepsilon_i \sim N(0, \sigma^2)$ .

Normality of the error distribution is an important assumption which justifies the use of a linear regression model. Accordingly, we decided to use log-transformations of the parking variables as it leads to more normality of the residual distribution. Besides, by using log-transformations, the estimated coefficients of the parking variables can be interpreted as elasticity. As a log transformation of a zero-value is not possible, zero-values of the variable “weighted average first hour parking tariff” are converted into 0.001 values. It is important to note that the influence of the parking variables on the turnover may differ between the functional classifications of the shopping areas. Multiple regression analyses, by taking the functional classifications of the shopping centres into consideration, are performed as well. However, the number of observations for the types ‘city centres’ (N=8) and ‘core centres’ (N=3) is too small to maintain reliable results when influences on the turnover are estimated.

Using the statistical program Eviews, the estimation method of Ordinary Least Squares (OLS) is used to obtain the coefficient-estimates. A significance level of 0.05 ( $\alpha = 5\%$ ) was used. Once the parameters are estimated the adequacy of the multiple regression models was checked with the Jarque-Bera (JB) test statistic. Additionally the Breuch-Pagan (BP) test-statistic, with a critical significance level of 0.05, was used to examine the presence of heteroskedasticity.

### 3.3 Results

The explanatory variables “percentage of shops selling daily products”, “population density” and “car density” have, respectively, VIF-scores of 6.54, 13.33 and 8.62 (see Table 3.2) indicating the presence of multicollinearity. Accordingly we transform the control variables into factor scores based on a PCA. By using the correlation matrix of the standardized control variables as input matrix, we obtain the PCA solution shown in Table 3.3.

For each control variable the rotated component loadings along with the communalities are given on the left hand side of Table 3.3. On the right side the component score matrix is given, which is used to obtain the factor scores for the multiple regression.

Although component 3 has an eigenvalue below unity (0.71), the PCA results are based on the extraction of the first three components. Usually, only components which reveal an eigenvalue greater than 1.00 are retained for analysis. However, when two components are considered, the communality score belonging to the variable “average income” will drop to 0.435. This means that the first two principal components explain only 43.5% of the variance of that variable. Additionally, retaining three components instead of two makes the PCA solutions better interpretable for the purpose of this paper. Hence, we decide to retain three components for subsequent analysis. In this way all original control variables are well represented by the components with a minimum communality score of 76.9%. The three components account for 88% of the variance across all variables. Given the rotated component loadings, the “degree of urbanization”, the “population density” and the “car density” of the surrounding area correlate heavily with component 1.

**Table 3.2: VIF-scores of the explanatory variables**

Explanatory variables	VIF-scores
Ln(capacity/sfs)	1.23
Ln(perc. street capacity)	1.42
Ln(average tariff)	1.34
Total SFS	2.17
Perc. selling points for daily products	6.54
Perc. SFS for daily products	4.83
Degree of urbanization	2.67
Population density	13.33
Car density	8.62
Average Income level	2.06

The average income level is closely associated with component 3, whereas the variables representing the characteristics of the shopping area are closely associated with component 2. Keeping in mind the associations between the variables and the components, the 3 factor scores, based on the component score matrix, are used for the multiple loglinear regression analysis.

Based on the full sample for which the turnover is known (N=80), a multiple regression analysis containing the factor scores was performed. The estimated coefficients for the parameters  $\beta_k$  along with the related standard errors, p-values and VIF-values are given in Table 3.4. Replacing the original control variables with the obtained factor scores leads to lower VIF-values. By that, the coefficient-estimates are not influenced by potential multicollinearity among the explanatory variables. As the BP statistic indicates the presence of heteroskedasticity, the standard errors displayed in table 3.4 are white-heteroskedasticity consistent. However, the significance of the coefficients may not be reliable as the JB test statistic is significant, which implies that the distribution of the residuals differs significantly from a standard normal distribution. This significant deviation from a standard normal distribution is mainly caused by observations 10 and 17. The residual values of these observations, respectively -1.23 and -1.34, are more than three times larger than the estimated standard deviation of the residuals (0.37). Accordingly, they can be considered as outliers. The regression results without including those two outliers are given on the right hand side of Table 3.4.

The coefficient of determination ( $R^2$ ) measures the amount of variation in the turnover of the shopping areas that is explained by the model. The adjusted R-square ( $R_{adj}^2$ ) corrects for the fact that multiple regressors are used in the regression analysis, leading to fewer degrees of freedom. Although the distribution of the residuals is not significantly different from a standard normal distribution anymore (JB-statistic=0.95), when excluding the outliers the explanatory power of the model (R-squares) drops from 16.6% to 9.6%.

After correction for non-normality, it can be concluded that the variable parking tariff contributes significantly to the model. The related coefficient reveals a positive sign, which contradicts the general belief of retailers that tends to associate higher parking tariffs with lower retail activity. In other words, the model shows that the higher the parking tariff the higher the turnover per SFS  $m^2$ . Furthermore, factor-score 1 and factor-score 3 have a significantly negative influence on the turnover of shopping areas. For example, with regard to factor-score 3, we find that the average income level within the surrounding area has, as

one would expect, a positive effect on turnover, as the variable income is negatively related with component 3 (see table 3.3).

### 3.3.1 Analysis per functional types

The outcome of the multiple loglinear regression analyses, when taking the functional categories of the shopping areas into consideration, is presented in Table 3.5. The number of observations for the city centres and core centres (respectively 8 and 3) is too small to obtain reliable results. Accordingly, only the regression results for the regional and district shopping areas are given.

Again, no VIF-values are observed above the critical level of five. Although performing a regression analysis on the shopping areas which belong to the functional category 'district centres' produces standard normally distributed residuals, the model itself is not significant ( $\Pr(F\text{-statistic}) > 0.05$ ). Accordingly, no statements can be made in respect of those results.

Regarding the regional shopping areas the adjusted R-square is 28.6%. Although the percentage is still not very high, it is higher than the previously observed values of 16.6% and 9.6% relating to the whole sample. This indicates that the variables used for the analysis explain more of the variation in turnover when regional shopping areas are considered. In this

case the parking capacity in the shopping areas has a significantly positive effect ( $\tilde{\beta}_k \approx 0.26$ ) on the turnover. This is not the case when the full sample is considered (Table 3.4).

Also factor-score 2, which is associated with the characteristics of the shopping area, has a significantly positive effect on turnover. Considering the PCA results shown in Table 3.3, it could be argued that the more the shopping area is dedicated to the sale of daily products in regional shopping areas, the higher the turnover is. The other factor-scores are not significant anymore.

**Table 3.3: PCA results (N=157)**

Variables	Rotated component loadings* and communalities			Component score coefficients			
	Component1	Component2	Component3	Communality	Component1	Component2	Component3
SFS	-0.856			0.769	0.085	-0.447	0.231
Perc. daily sp	0.801			0.876	0.056	0.298	0.079
Perc. daily sfs	0.903			0.869	0.02	0.416	-0.129
Urban degree	-0.871			0.827	-0.394	0.134	0.118
Pop. density	0.869			0.942	0.31	0.013	0.117
Car density	0.927			0.897	0.406	0.08	-0.212
Income			-0.953	0.978	0.171	0.222	-1.025

Variances: comp. 1 = 48.02%, comp. 2 = 29.85%, comp. 3 = 10.10%, Eigenvalues: comp. 1 = 3.36, comp. 2 = 2.09, comp. 3 = 0.71

\* = loading below 0.5 are suppressed

**Table 3.4: Loglinear regression analyses**

Variables	Full sample				Full sample without observations 10 and 17				
	Coefficients	SE	P-value	VIF	Variables	Coefficients	SE	P-value	VIF
C	8.27	0.28	0.00		C	8.53	0.23	0.00	
Ln(capacity/sfs)	-0.01	0.10	0.93	1.32	Ln(capacity/sfs)	0.08	0.08	0.34	1.27
Ln(perc_street)	-0.02	0.06	0.74	1.38	Ln(perc_street)	-0.01	0.04	0.74	1.39
Ln(tariff)	0.06	0.03	0.02	1.29	Ln(tariff)	0.07	0.02	0.00	1.28
Factor_score1	-0.11	0.05	0.04	1.62	Factor_score1	-0.08	0.04	0.04	1.54
Factor_score2	-0.05	0.05	0.35	1.46	Factor_score2	-0.03	0.04	0.47	1.43
Factor_score3	-0.12	0.05	0.03	1.08	Factor_score3	-0.08	0.04	0.05	1.09

Obs. = 80, R-sq = 23.0%, R-sq(adj) = 16.6%, Pr(F-statistic) = 0.00, Pr(JB-statistic) = 0.00, Pr(BP-statistic) = 0.00  
 Obs. = 78, R-sq = 16.6%, R-sq(adj) = 9.6%, Pr(F-statistic) = 0.04, Pr(JB-statistic) = 0.95, Pr(BP-statistic) = 0.00

**Table 3.5: Loglinear regression analyses per functional areas**

Regional Shopping Areas				District Centers					
Variables	Coefficients	SE	P-value	VIF	Variables	Coefficients	SE	P-value	VIF
C	9.15	0.21	0.00		C	7.96	0.52	0.00	
Ln(capacity/sfs)	0.26	0.07	0.00	1.07	Ln(capacity/sfs)	-0.09	0.14	0.54	1.38
Ln(perc_street)	0.00	0.04	0.99	1.36	Ln(perc_street)	-0.23	0.50	0.65	2.21
Ln(tariff)	0.11	0.09	0.23	1.71	Ln(tariff)	-0.67	0.64	0.31	2.95
Factor_score1	-0.01	0.05	0.86	2.15	Factor_score1	0.10	0.23	0.67	3.66
Factor_score2	0.14	0.06	0.03	1.76	Factor_score2	0.02	0.16	0.90	1.81
Factor_score3	-0.03	0.04	0.45	1.72	Factor_score3	-0.18	0.09	0.05	1.46

Obs = 40, R-sq = 39.6%, R-sq(adj) = 28.6%, Pr(F-statistic) = 0.01, Pr(JB-statistic) = 0.08, Pr(BP-statistic) = 0.16

Obs = 29, R-sq = 24.0%, R-sq(adj) = 3.3%, Pr(F-statistic) = 0.36, Pr(JB-statistic) = 0.86, Pr(BP-statistic) = 0.20



## 3.4 Conclusions and policy implications

### 3.4.1 Discussion of the results

The outcome of the statistical analyses performed in the previous section provides a contribution to a better understanding of the importance of parking for shopping areas. We can identify three major results that help to answer the central research question of this paper – is parking supply related to turnover of shopping areas?

First, we find a positive significant relationship between parking tariffs and turnover per SFS  $m^2$ . This outcome suggests that higher parking fees are associated to higher turnovers per SFS  $m^2$  in shopping areas, in contrast to what is generally believed by retailers. Although this might seem strange, a simple explanation can be found. It is reasonable to assume that the highest levels of turnover per SFS  $m^2$  correspond to the most attractive shopping areas, those that attract most customers. In these shopping areas customers compete for parking that, independent of the type of shopping area, is always a scarce good and, ergo, can be charged. This is indirectly supported by Hensher and King (2001) who investigate the role of parking pricing and supply in the central business district of Sidney. They suggest that drivers parking close to their retail activity areas are not significantly affected by parking prices in their decision where to park.

Second, considering the whole database used for the analysis we find that parking capacity has no influence on turnover of shopping areas. Once more, this is in contrast to the dogma ‘no parking, no business’. Most certainly the success of a shopping area depends on its attractiveness. In turn, the attractiveness might depend on several factors, i.e. quantity and quality of the shops, visitor-friendliness, location, accessibility, etc. According to the results of our analysis, the number of parking places available in a shopping area might not be one of these factors.

Third, specifically for the category ‘regional shopping areas’ we find a significant positive relationship between parking capacity and turnover. Given their specific nature, these kind of shopping areas tend to attract visitors from a wide area and this might explain why the possibility to use the car has an influence on turnover. In this case the findings are in accordance to the retailers’ philosophy, though only 28.6% of the variation in turnover is explained by the model.

At this point it is interesting to calculate the financial implications of this last finding; for regional shopping areas we find an elasticity level of 0.26 (see Table 3.5), meaning that an increase of 1% of the parking capacity leads to an increase in 0.26% of the turnover per  $m^2$ . The regional shopping areas included in this study have an average SFS of 41,429  $m^2$ , an average supply of 2,364 parking spaces and an average yearly turnover of €175,425,000.00 or €4,234.55 per SFS  $m^2$ . Accordingly, an increase of 1% of the parking capacity – 23.6 extra parking spaces – leads to an increase of €456,105 in the yearly turnover, or €11.01 per SFS  $m^2$ . The average investment cost of a parking place in the Netherlands ranges from a minimum of €3,500 for an on street parking space to a maximum of €60,000 for a space in an underground car park (Brugmans, 2008). Considering an average cost of €30,000 per parking place, the investment costs related to that 1% increase in parking are €708,000 and the related yearly depreciation costs are €35,400, considering an average yearly amortization rate of 5%. Accordingly almost 8% of the extra turnover must be used to cover the additional parking

costs. Whether the investment on the extra parking capacity is profitable or not depends on the profit margin of the shopping areas that, of course, differs from one shopping area to the other.

It is beyond the scope of the present paper to investigate the profitability of shopping areas investing in additional parking capacity. Nonetheless, based on these findings we can state that the dogma “no parking, no business” is not correct. More specifically it is not correct to assume that shopping areas where parking is charged and/or with high parking tariffs might be disadvantaged compared to shopping areas with free parking and/or lower parking tariffs. Moreover, it is not correct to assume that parking capacity has a direct influence on the commercial success of shopping areas. A higher parking capacity (per SFS m<sup>2</sup>) does not necessarily lead to higher turnover (per SFS m<sup>2</sup>). In accordance with other authors (e.g. Teller, 2008; Anselmsson, 2006; Haringsma, 2008) the success of a shopping area does not depend on parking but on other factors; mainly the atmosphere and the quality of the retail mix. An important exception must be made for regional shopping areas, i.e. those shopping areas that have a regional catchment area and, accordingly, might be particularly oriented towards car travel. In this case parking capacity, but not price, does have an influence on turnover.

### 3.4.2 Policy implications

This study concerns the relationship between parking and turnover in 80 shopping areas in the Netherlands. The findings are supported by other research done in the same country (e.g. Christianens, 2000; Verhoek, 2008; Mingardo, 2009). At this point we should wonder whether these findings might hold also for other countries. The Netherlands is well known in Europe for having a high level of bicycle use. In 2008 one fourth of all trips in the country were made by bicycle (KiM, 2009). More specifically, for shopping related trips only 47.6% are made by car whilst 28.8% are by bicycle (Ministerie van Verkeer en Waterstaat, 2006). However there is evidence in other European countries that the importance of car drivers as customers is often overestimated (e.g. Sustrans 2003, 2006; Teller, 2008; Anselmsson, 2006). Accordingly the policy implications discussed in the following part of this section, though based on findings for the Netherlands, might be relevant also for other countries.

Local authorities often must deal with requests from retailers and their representatives to increase parking capacity and/or to reduce or freeze parking tariffs in and around shopping areas. This puts the local authority under pressure because this kind of policy might be in contrast with other policy objectives to reduce car use, to improve air quality and, more in general, to achieve sustainable mobility. The main driver of the retail sector is the dogma that parking plays a crucial role in the success of shopping areas, often referred to with the motto “no parking, no business”. This study shows that this dogma is mostly incorrect. Accordingly we can derive four major implications for policy.

First, the findings might help planners in the debate about parking with the retail sector. Very often this debate is based on feelings and emotions rather than on facts. We provide evidence that parking might be less important for shopping area turnover and profitability than is generally believed.

Second, the results might support local authorities willing to implement restrictive parking policy, both in terms of reduced capacity and/or in terms of increased tariffs. With a specific exception the findings show that both measures, on their own, are not harmful for the turnover of shopping areas.

Third, the outcomes might also help local authorities and project developers to build less parking capacity in new (re)developments. The construction costs of parking are very high – estimated at €30,000.00 - 40,000.00 per parking space in the Netherlands. Reducing the need for parking will considerably reduce construction costs.

Fourth, the rough monetary calculation performed in Section 3.4.1 suggests that, even when there is a significant positive relationship between parking capacity and turnover, the investment in parking might not be feasible from a financial point of view for all shopping areas.

### **3.4.3 Limitations and suggestions for further research**

Factors like the perceived safety or atmosphere of a shopping area may have a strong underlying role when the influence of parking on the turnover is examined. Controlling for these factors may lead to different results than those found in this paper. The fact that these factors are not included leads to some reservations about the reliability of the results. Nevertheless, we do believe the outcomes of this explorative research contribute to the discussion about the role of parking in the retail sector. Additionally our findings could be used as a basis for further research.

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# Appendix

**Table A 3.1: Amount of observations used for the analysis**

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Analysis	Observations
Calculating VIF-scores	156
Principal Component Analysis	157
Loglinear regression on full sample	80
Loglinear regression given regional areas	40
Loglinear regression given district areas	29

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## 4 Transport and environmental effects of rail-based Park and Ride: Evidence from the Netherlands<sup>23</sup>

### 4.1 Introduction

The last two decades have witnessed a crescendo of Transport Demand Management strategies implemented by European urban transport planners and policy makers. Among others, the proliferation of Park and Ride (P&R) facilities has grown significantly. In the Netherlands, for example, the first official P&R was introduced in 1979 in Schagen, a small town located north of Amsterdam. By the end of the '80s, more than 50 official P&R facilities were in use; 386 P&R facilities were in operation in the country in 2003 (CROW, 2004). Yet the impact of this kind of infrastructure on trip making and regional development is ambiguous. On the one hand, many policy makers seem to trust the effectiveness of P&R in easing traffic congestion and increasing the city's accessibility and quality of life. On the other hand, some studies have questioned the real impact of P&R, especially in terms of reduction of car use (Meek et al., 2009).

Most literature on P&R facilities can be divided in two main groups. The first focuses on mathematical models that analyze the [potential] impact of P&R facilities (Cousins, 1978; Hole, 2004; Wang et al., 2004; Ping, 2010; Hounsell et al., 2011; Karamychev and van Reeven, 2011). The second (larger) group includes papers that consider the policy implementation and effects of P&R schemes. Studies within this group provide abundant evidence suggesting that P&Rs might have counter-productive effects with respect to the original policy goals that are usually meant to be achieved. Dickins (1991) analyzed information regarding 25 P&Rs in cities in Europe and North America and was the first to suggest that P&R schemes do not always result in reduction of congestion, partially due to the phenomenon of induced demand. Parkhurst (1995; 2000a) provided additional evidence that [UK] bus-based P&R facilities lead to so-called “unintended effects” – mainly abstraction from public transport and trip generation – and concluded that the main effects of P&Rs might be spatial traffic redistribution rather than reduction. Similar conclusions are provided by Topp (2005), who discussed P&R in Munich, [Germany]. More recently, Meek, Ison and

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Enoch studied P&Rs extensively in the UK. Firstly (Meek et al., 2009; 2010), they analyzed the most important reasons for local authorities to implement P&R schemes, concluding that P&Rs might be seen as a tool to achieve a range of (political) goals which extend beyond traffic reduction. Next, Meek et al. (2011) tested a range of alternative concepts of bus-based P&Rs that might considerably improve the impact on vehicle miles travelled.

This paper presents the results of a users' survey (N=738) conducted within nine rail-based P&Rs located around the cities of Rotterdam and The Hague in The Netherlands in 2008 and 2009. The main aim of this survey was to understand the impact of this popular transport infrastructure in terms of vehicle km travelled (VKT) and emissions (CO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub>). The paper builds on the work of Parkhurst (1995; 2000a) and Meek et al. (2009; 2010; 2011) and adds empirical evidence that might contribute to a better understanding of the impact the different types of P&R might have on travel behaviour and car use. While existing literature focuses mainly on bus-based P&Rs, this work analyses the use of rail-based P&Rs (tram, metro and train).

The paper is organized as follows: Section 4.2 describes the framework of analysis and Section 4.3 the methodology used for the research. Next, in Sections 4.4 and 4.5, the results for Rotterdam and The Hague are presented. In Section 4.6, the conclusions are presented. Finally, Section 4.7 discusses a number of policy implications.

## 4.2 P&R: Types and effects on traffic

On the basis of their location, three categories of P&R can be distinguished (EU, 2005; Meek et al, 2008):

- a) Remote P&R, with the origin function of collecting drivers at the beginning of their commutes. These are usually located close to users' homes, in suburban residential areas.
- b) Peripheral P&R, with a destination function whose aim is to intercept drivers just before their final destination. These are usually located at the edge of town.
- c) Local P&R with a field function used to intercept drivers somewhere along their trip between the origin and the destination. These facilities are normally situated in non-residential suburban areas, along main transport corridors.

Additional [theoretical] approaches to bus-based P&R have also been suggested. Parkhurst (2000b) introduced the Link and Ride concept, providing smaller interchange facilities located along the main transport corridors serving an existing, but enhanced, public transport route. Meek et al. (2011) went further, suggesting five alternative interchange concepts:

- Demand-led concept: offering less frequent [dedicated] bus service in order to better reflect demand;
- Integrated concept: making use of conventional bus services;
- Hub-and-Spoke concept: suggesting the use of small feeder services for P&R locations;
- Remote Site concept: see point b) above;
- Link and Ride concept: based on Parkhurst's idea.

The effects of P&R on traffic have been discussed extensively in the literature, though mainly on the basis of UK bus-based P&R. This discussion can be shortly summarized in the words of Meek et al. (2009, p. 468), who suggested that "P&R [...] can have a limited or even



counter-productive effect on its policy goals, particularly those to reduce car use”. While policy makers consider P&R a tool to intercept motorists before they approach congested urban areas, evidence suggests that normal P&R policies lead to the so-called “unintended effects”. These translate into higher, not lower, car use around urban areas. Based on research from five selected countries, Table 4.1 shows that the following four categories of unintended effects can be found:

- *Abstraction from public transport*: not all P&R users drove cars to the city centre prior to the provision of the facilities, partly because a proportion of users switched modes from public transport services.
- *Abstraction from bike*: P&R users that prior to the provision of the facilities were making the whole trip by bike.
- *Trip generation*: some extra journeys are made to the city centre via P&R sites. The suspected mechanism is that introducing park and ride has lowered the generalized cost of travel.
- *Park and walk users*: drivers use P&R as normal parking facilities, without making use of the public transport link to the city centre, mainly because the P&R is located within walking distance from their final destination.

**Table 4.1: Evidence of some unintended effects of P&R facilities in five selected countries.**

	United Kingdom	Netherlands	Germany	Switzerland	United States
<b>Abstraction from public transport</b>	Parkhurst (2000a); Parkhurst and Richardson (2002)	MuConsult (2000); Mingardo (2003); Kramer and van Kooij (2004); Holwerda and van Dalen (2006)	Studiengesellschaft Nahverkehr mbH (1991) Guillaume-Gentil et al (2006)	Guillaume-Gentil et al (2006)	Merriman (1998); TRB (2004)
<b>Abstraction from bike</b>	-	Mingardo (2003)	Studiengesellschaft Nahverkehr mbH (1991) Guillaume-Gentil et al (2006)	-	-
<b>Trip generation</b>	Parkhurst (2000a); Parkhurst and Richardson (2002)	MuConsult (2000); Mingardo (2003); Kramer and van Kooij (2004); Holwerda and van Dalen (2006)	-	-	-
<b>Park and walk users</b>	-	MuConsult (2000); Mingardo (2003); Kramer and van Kooij (2004)	-	-	Merriman (1998); TRB (2004)

Due to the presence of these negative effects, P&R facilities do present a net increase in traffic volume rather than a reduction. Indeed, the number of car-km saved from the P&R site to the inner city is usually more than compensated by the increase in car-km travelled to reach the P&R site by those users who switched from public transport services and bikes, those that were previously not travelling and (possibly) the Park and walk users.

Parkhurst (2000a) found that the net traffic implications of eight out-of-town P&Rs in England are an increase in traffic in the overall road network. The increase is up to 20.7 car-

km per intercepted car. A similar result has been reported by Guillaume-Gentil et al. (2006), concerning five out-of-town P&Rs in Lausanne. Their usage leads to an increase of more than 50% in terms of km travelled.

Finally, it is not possible to demonstrate that P&R lead to a net reduction of downtown traffic. Suppressed demand probably replaces the cars intercepted at the P&R sites. Although there is no evidence for this unintended effect, Parkhurst refers to it as a “lack of evidence for traffic reduction” (Parkhurst, 2000a p. 160).

### 4.3 Methodology

Two questionnaire-based users' surveys and specific field observations were conducted in 2008 and 2009 at nine rail-based [train, metro and conventional train] P&Rs located in the metropolitan areas of Rotterdam and The Hague: three P&R facilities in Rotterdam (Kralingse Zoom, Slinge and Alexander) and six in The Hague (Voorburg, Ypenburg, Zoetermeer Plein der Verenigde Naties, Delft Zuid, Zoetermeer Voorweg and Den Haag Mariahoeve). The smallest P&R facility is Ypenburg (only 15 parking places), the largest Kralingse Zoom (730 parking places). Both surveys were commissioned by the municipalities of Rotterdam and The Hague with the aim to understand the effects that P&Rs have on the economy, accessibility and quality of life of the two cities and their metropolitan areas (Mingardo, 2008; 2009).

Questionnaires included 10 questions seeking mainly to collect information about users' travel behaviour, the perceived quality of the P&R service and users' reactions to the introduction of a daily parking fee in the P&R site. Additionally, the interviewers reported the gender of the user and the number of occupants per car.

A total of 738 questionnaires have been collected: 543 in the three locations in the Rotterdam area and 195 in the six locations in the metropolitan area of The Hague. Questionnaires have been collected during all days of the week, in the afternoon, when users were mainly on their journey back to home. This was done in order to increase the response. Generally speaking, on their way home, people are less in a hurry and more willing to respond to a questionnaire.

The questionnaire conducted in the Rotterdam area was identical of the one performed in the P&R around The Hague with the exception of the question concerning the introduction of the price to park the car in the P&R; at that time, all P&R facilities as objects of the surveys were free of charge. While in Rotterdam, users were asked how they would have reacted to a daily parking tariff of €1-2; in The Hague, the price was set at €3-4. This difference is explained by the differences in potential parking tariffs that the two local authorities were intentioned to introduce. Table 4.2 presents the most important outcomes.

	Kralings e Zoom	Alexander	Slinge	Average Rotterdam	Voorburg	Ypenburg	Zoet. VN	Zoet. V.	Delft Zuid	Mariahoe ve	Average The Hague
<b>1) Reason for travelling:</b>											
Work [commuting or business visit]	68.4	80.6	82.5	<b>76.2</b>	81.8	92.9	68.9	93.1	77.5	68.9	<b>77.8</b>
Study	3.4	4.0	3.8	<b>3.7</b>	4.5	7.1	4.4	-	10.0	2.3	<b>4.6</b>
Leisure/shopping	25.7	9.7	9.0	<b>15.4</b>	13.6	-	20.0	-	7.5	18.2	<b>11.9</b>
Other	2.4	5.6	4.7	<b>4.7</b>	-	-	6.7	6.9	5.0	9.1	<b>5.7</b>
<b>2) Final destination</b>											
City Centre	99.5	19.3	88.6	<b>72.7</b>	18.2	21.4	51.1	82.8	15.0	2.2	<b>30.2</b>
Amsterdam region	-	15.3	0.5	<b>3.7</b>	4.5	21.4	6.7	-	10.0	71.1	<b>22.1</b>
Utrecht region	-	41.1	0.9	<b>9.7</b>	50.0	42.9	20.0	-	2.5	2.2	<b>14.4</b>
Rotterdam region	-	-	-	<b>-</b>	-	-	2.2	3.4	57.5	2.2	<b>13.3</b>
The Hague / Gouda region	0.5	10.5	0.5	<b>2.7</b>	-	-	-	-	-	-	<b>-</b>
Other areas in the Randstad	-	-	-	<b>-</b>	9.1	14.3	11.1	13.8	10.0	17.8	<b>12.8</b>
Other areas outside the Randstad	-	-	-	<b>-</b>	18.2	-	8.9	-	5.0	4.4	<b>6.2</b>
<b>3) Modal split previous the P&amp;R:</b>											
By car to the final destination	27.1	19.7	23.1	<b>23.4</b>	9.1	23.1	15.9	21.4	17.5	26.2	<b>19.0</b>
By public transport to the final destination	34.0	27.9	30.2	<b>30.6</b>	59.1	30.8	50.0	42.9	22.5	23.8	<b>37.0</b>
By bike to the final destination	3.4	5.7	2.8	<b>3.7</b>	4.5	-	9.1	7.1	7.5	-	<b>5.3</b>
Parking the car around another PT terminal	-	-	-	<b>-</b>	13.6	7.7	9.1	14.3	25.0	38.1	<b>20.1</b>
By bike to the PT terminal	34.5	46.7	41.0	<b>39.2</b>	9.1	38.5	11.4	14.3	27.5	11.9	<b>16.9</b>
Extra trip	-	-	-	<b>-</b>	4.5	-	4.5	-	-	-	<b>1.6</b>
<b>4) Reasons for choosing the P&amp;R:</b>											
a) Cheaper	32.5	23.4	26.3	<b>27.7</b>	19.0	7.1	16.3	10.3	10.0	13.3	<b>13.0</b>
b) Faster	27.1	24.2	20.7	<b>23.6</b>	23.8	35.7	20.9	34.5	27.5	17.8	<b>25.0</b>
c) More comfortable	29.6	37.1	38.0	<b>34.2</b>	52.4	14.3	37.2	41.4	45.0	48.9	<b>42.2</b>
Combination of a/b/c	-	-	-	<b>-</b>	-	28.5	9.3	10.3	10.0	17.8	<b>12.0</b>
No reason	10.8	15.3	15.0	<b>13.4</b>	4.8	14.3	16.3	3.4	7.5	2.2	<b>7.8</b>

**5) Reaction to a daily parking tariff [€1-2 in Rotterdam; €3-4 in The Hague]:**

Still make use of the P&R	53.9	54.8	44.3	<b>50.0</b>	19.0	28.6	24.4	6.9	22.5	29.5	<b>22.3</b>
By car to the final destination	15.0	8.9	15.6	<b>13.7</b>	-	7.1	11.1	20.7	10.0	13.6	<b>11.4</b>
Parking the car somewhere else nearby the PT terminal	-	-	-	-	19.0	7.1	13.3	6.9	27.5	18.2	<b>16.6</b>
The whole trip by public transport	16.5	15.3	17.0	<b>16.3</b>	33.3	-	24.4	34.5	7.5	22.7	<b>21.2</b>
By bike to the final destination or to the PT terminal	3.9	9.7	5.7	<b>5.9</b>	19.0	50.0	22.2	31.0	25.0	15.9	<b>24.4</b>
Not traveling anymore	2.4	0.8	0.5	<b>1.3</b>	-	-	-	-	2.5	-	<b>0.5</b>
Don't know	7.8	10.5	17.0	<b>11.9</b>	9.5	7.1	4.4	-	5.0	-	<b>3.6</b>

**Table 4.2: Outcomes of the users' surveys for the P&R facilities in Rotterdam and The Hague (selected results)**

The field observations were made in five of the nine P&R sites – the three P&Rs in Rotterdam and the P&Rs Mariahoeve and Voorburg in The Hague – with the specific aim to measure the existence of the unintended effect of “Park and walk users”. This happens when the motorist parks his car in the P&R facility but does not continue the trip by public transport and simply uses the P&R for parking close to his final destination (mostly offices located nearby). Observations were done during the morning peak hours; the researchers observed the behaviour of motorists parking in the P&R to understand whether, after parking the car, they were walking toward the rail station or in other directions.

Finally, a postal code analysis was used to estimate the assumed driving distances between the origin and destination of the users. The postal code of users’ homes was known, while the postal code of the public transport stop where users exit the public transport was used as a proxy for the final destination. The driving distance was calculated through the official route planner of the major Dutch car drivers association (ANWB). In this way, it is possible to estimate the amount of vehicle km travelled (VKT) by car and the related vehicle emissions (CO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub>) generated and saved by the P&R users. To calculate the vehicle emissions, estimated data for the 2010 Dutch car fleet have been used: an average of 176 g/km CO<sub>2</sub>; 0.31 g/km NO<sub>x</sub> and 0.016 g/km PM<sub>10</sub>. These values have been calculated by CE Delft using a wide range of raw data covering both real-world average vehicle performance and specific Euro emission classes (den Boer et al., 2008).

The case of Rotterdam includes two peripheral P&Rs (Kralingse Zoom and Slinge) and one mixed-function P&R (Alexander). The six P&Rs in the metropolitan area of The Hague can be considered as remote P&Rs.

## 4.4 Rotterdam

### *Users*

The P&Rs in Rotterdam are used mostly for work-related trips (76.2%) and to a lesser extent for leisure (15.4%). Almost all of the work-related trips (98.3%) are made during the week, while 60.4% of visitors use the P&Rs on the weekend. Additionally, almost 90% of all users are “solo drivers”. This clearly suggests that P&Rs in Rotterdam are mainly used for working purposes – commuting and other business-related trips.

### *Type of P&R*

The most important destination of the users’ trips is the city centre (72.7%); 9.7% of users consider the metropolitan area of Utrecht as their final destination. This result is of course strongly influenced by the outcome for the P&R Alexander, where almost 67% of users do not travel to Rotterdam. Accordingly, the P&R Alexander has a mixed function; it operates as a peripheral P&R for the users with a final destination as the city of Rotterdam and as a remote and local P&R for those users whose final destination is Amsterdam, Utrecht or The Hague regions. This is supported by the postal code analysis of users’ homes as shown in Figures 4.1 to 4.3. This indicates that most users of the P&R Alexander (Figure 4.1) live in the proximity of the P&R facility. The other two facilities – Kralingse Zoom and Slinge – are typical peripheral P&Rs attracting users from a larger area and having the city centre as a main final destination.

**Frequency and reasons**

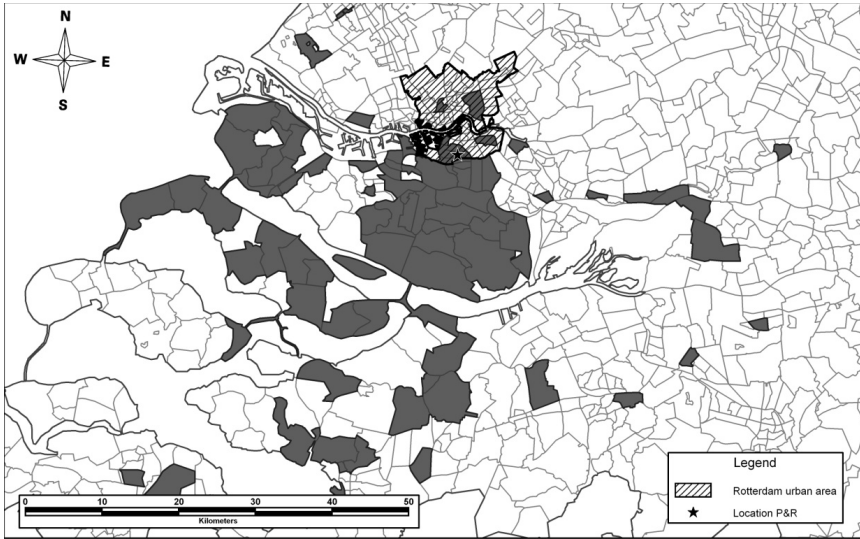
Consistent with the greatest reason for the trips – work-related activities – most users (47.3%) make use of the P&R four or five times a week. On the other hand, most visitors use the P&R facilities once a week or less. Comfort is the most important reason for motorists to make use of the P&R (34.2%), followed by the lower costs of the trips (27.7%) and reduced travel time (23.7%). In general, users have a positive opinion about the public transport link, in terms of frequency and safety, and about the facility. The P&R facility scores higher in terms of safety than cleanliness.



**Figure 4.1: Origins of the users of the P&R Alexander [Rotterdam]**



**Figure 4.2: Origins of the users of the P&R Kralingse Zoom [Rotterdam]**



**Figure 4.3: Origins of the users of the P&R Slinge [Rotterdam]**

### *Unintended effects*

In order to estimate the transport and environmental effects of P&R use, users were asked if and how they would have to perform the same trip in the absence of the P&R (see outcome of question 3 in Table 4.2). The results are as follows<sup>24</sup>:

- 23.4% of users would use a car to reach their final destination [intended effect];
- 30.6% would use public transport [unintended effect, abstraction from public transport];
- 3.7% would use a bicycle [unintended effect, abstraction from bike];
- 39.2% would not make the trip – this result is influenced by the fact that most of these people were simply not travelling before the existence of the P&Rs. In other words, these facilities are long established in Rotterdam, and for most travellers, there was no ‘before’; they have always travelled through the P&R. Accordingly, there is no evidence to consider this category as demonstrating the unintended effect ‘trip generation’.

The P&R facility Kralingse Zoom intercepts the most motorists (27.1%) but also generates the highest level of abstraction from public transport (34.0%). Considering the reasons users choose to use the P&R, we notice the following:

- Abstraction from public transport: the most important reasons for switching from public transport to car for the first part of the journey are comfort (37.3%) and speed (32.5%). It is interesting that 18.2% of these users switched from public transport to car use for the first part of their trip for financial reasons. This suggests that, for this group of users, the car is [perceived as] a cheaper option than public transport.

<sup>24</sup> This question makes use of stated preferences. Accordingly, there might be a biased response; users might not be completely aware of their travel alternatives (e.g., they probably don’t know whether there is parking available at the final destination or how long the whole trip would take by public transport or by bike). However, the vast majority of the users travel for work or study-related activities, thus being regular travellers. In this case, it is safe to assume that they might have a good perception of travel alternatives.

- Abstraction from bike: not surprising is that comfort is the most important reason to switch from the bicycle to the car. Interestingly, for only 15% of these users, speed is the reason for the switch.

Additionally, the unintended effect “Park and walk users” was detected by field observation in all three locations. This effect strongly varies among the three facilities, being the largest in Kralingse Zoom (almost 15% of the users) and the smallest in Slinge (less than 6%). The presence of a large business park and the close proximity of the university to the P&R Kralingse Zoom might explain the high percentage of “Park and walk users”.

### *Transport and environmental effects*

Table 4.3 shows the results of the postal code analysis. Considering the users who would have driven or who did not travel prior the introduction of the P&R, the reduction for the whole sample is equal to 1,559 VKT or 274.4 Kg of CO<sub>2</sub>. On the other hand, the extra VKT generated by the abstraction from public transport and bicycle amount to, respectively, 2,710 and 121. The net effect caused by the 543 users that have been surveyed is an additional 1,272 VKT or 223.9 Kg of CO<sub>2</sub>. Large differences can be observed among the three facilities where the two peripheral P&R – Kralingse Zoom and Slinge – generate a net increase in car-km while the mixed-function P&R Alexander produces a net decrease.

**Table 4.3: Transport [divided per P&R location] and environmental [cumulative] effects of the P&R locations in Rotterdam**

	Kralingse Zoom	Alexander	Slinge	Total	Total emissions in kg CO <sub>2</sub>	Total emissions in g NO <sub>x</sub>	Total emissions in g PM <sub>10</sub>
<b>Total reduction in VKT (A)</b>	<b>-552</b>	<b>-204</b>	<b>-803</b>	<b>-1,559</b>	<b>- 274.4</b>	<b>- 483.3</b>	<b>- 24.9</b>
Extra VKT abstraction from public transport	1,508	54	1,148	2,710	477	840.1	43.4
Extra VKT abstraction from bike	72	4	45	121	21.3	37.5	1.9
<b>Total extra VKT (B)</b>	<b>1,580</b>	<b>58</b>	<b>1,193</b>	<b>2,831</b>			
<b>Net change (B-A)</b>	<b>+1,028</b>	<b>-146</b>	<b>+390</b>	<b>+ 1,272</b>	<b>+223.9</b>	<b>+394.3</b>	<b>+20,4</b>

Finally, if a daily tariff of €1-2 for parking would be introduced, half of the respondents stated they would still make use of the P&R (see Table 4.4); 13.7% would drive their cars to their final destinations, 16.3% would use public transport for the whole trip and 6% would use a bike. Apparently, the introduction of a fee might reduce the unintended effects: 31.3% of the former public transport users would go back to the public transport for the whole trip, and 45% of the former bikers would use the bike again for the whole trip. It is interesting to highlight that the introduction of a pricing policy would have a very limited effect on those travelling for leisure: almost 70% of them would keep using the P&Rs, and none would abstain from going to the city any longer because of the fee. This is not unexpected, as leisure



trips are likely to be multiple-occupant car trips to the P&R, which would incur multiple additional public transport costs if transferred.

**Table 4.4: Reaction to the introduction of a daily fee of €1-2 by users of the P&R locations in Rotterdam**

	%
Continue to use the P&R	50.0
By car to the final destination	13.7
By public transport to the final destination	16.3
By bike to the final destination	5.9
Not making the same kind of trip anymore	1.3
Do not know	11.9
<b>Total</b>	<b>100.0</b>

## 4.5 The Hague

### *Users*

In terms of users' profiles, the P&R facilities in The Hague are similar to those in Rotterdam. They are mostly used for work-related trips (77.8%), and almost all of these trips take place during the week (98.7%). Visitors (11.9%) travel mostly during the weekend (78.3%). Almost 90% of all users are 'solo drivers'.

### *Type of P&R*

When analyzing users' final destinations, a fundamental difference from Rotterdam can be seen. The majority of the sample (68.8%) doesn't travel to the city of The Hague but to other destinations within the Randstad. Accordingly, the P&Rs in urban areas in The Hague have mainly a remote function, serving mainly nearby residents working in other urban areas. Only the locations of Zoetemeer Voorweg and, to a lesser extent, Zoetemeer V.N. can be considered as peripheral P&Rs for the city of The Hague (see Table 4.2). These results are supported by the postal code analysis of users' homes as shown in Figures 4.4 to 4.9.

### *Frequency and reasons*

Considering the reasons for the trip, like in Rotterdam, in The Hague, most users (48.1%) make use of the P&Rs four or five times a week. On the other hand, almost all of the visitors (95.7%) use the P&R facilities only once a week or less. Comfort (42.2%) and reduced travel time (25.0%) are the most important reasons for using the P&R. Similar to Rotterdam, users have a positive opinion about the public transport link in terms of frequency and safety and about the facility; again for the latter, safety scores are higher than those for cleanliness.

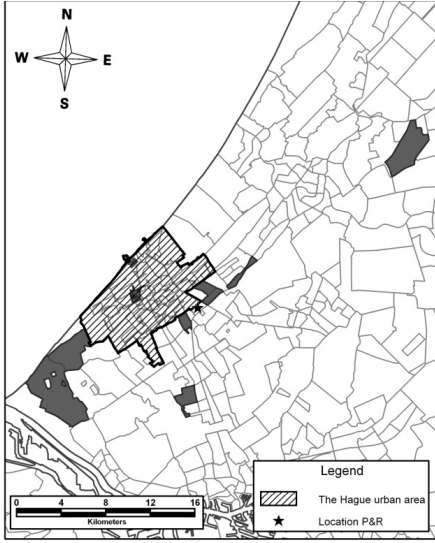


Figure 4.4: Origins of the users of the P&R Voorburg [The Hague]

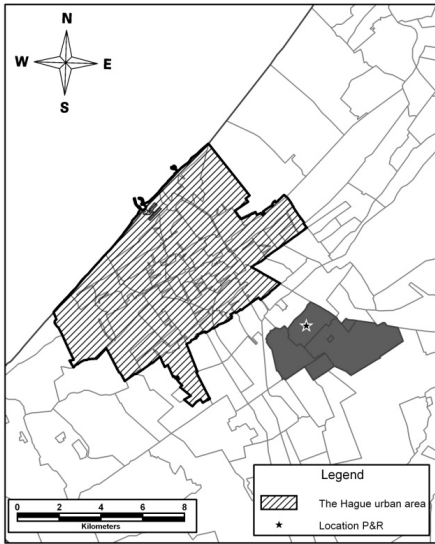


Figure 4.5: Origins of the users of the P&R Ypenburg [The Hague]

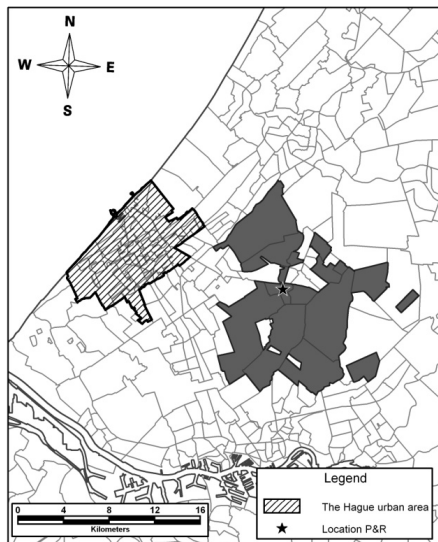


Figure 4.6: Origins of the users of the P&R Zoetermeer VN [The Hague]

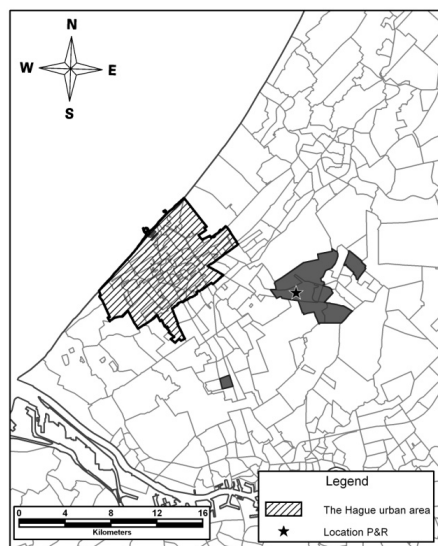
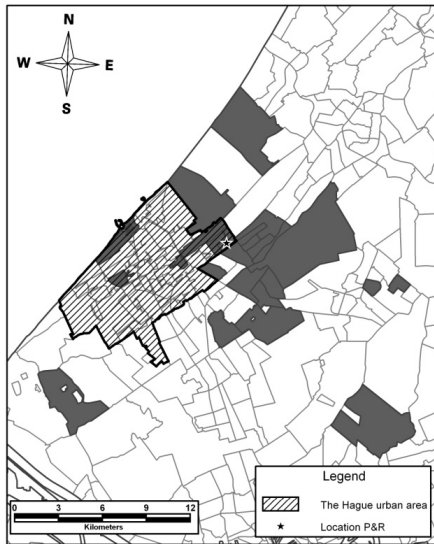


Figure 4.7: Origins of the users of the P&R Zoetermeer Voorweg [The Hague]



**Figure 4.8: Origins of the users of the P&R Delft Zuid [The Hague]**



**Figure 4.9: Origins of the users of the P&R Mariahoeve [The Hague]**

### *Unintended effects*

The analysis of the unintended effects of P&R use shows the following results:

- 19.0% of users would use their cars to reach their final destination [intended effect];
- 37.0% would use public transport [unintended effect, ‘abstraction from public transport’];
- 5.3% would use a bicycle [unintended effect, ‘abstraction from bike’];
- 20.1% would park their cars somewhere else in proximity to the public transport terminal;
- 16.9% would use a bike to reach the public transport terminal [unintended effect, ‘partial abstraction from bike’];
- 1.6% would not make the trip.

Two additional effects are observed in comparison to the Rotterdam case – one negative, one positive. First, public transport users who usually cycle to the terminal might switch to a car when an official P&R facility is created. Second, the P&R seems to reduce the parking pressure on some areas adjacent to the terminal. The latter can be very important, especially when the terminal is located close to or in residential areas.

The P&R facilities Mariahoeve en Ypenburg intercept the most motorists (respectively, 26.2% and 23.1%); Zoetemeer VN, Zoetemeer Voorweg and Voorburg are those that generate the highest level of abstraction from public transport (respectively, 50.0%, 42.9% and 59.1%). Analyzing the reasons for choosing the P&R, we observe the following:

- Abstraction from public transport: clearly the most important reason for switching from public transport to car for the first part of the journey is comfort (45.6%). Like in Rotterdam, for some users (13.2%) the car is [perceived as] a cheaper option than the public transport.
- Abstraction from bike: again, comfort is the most important reason (50.0%) to switch from the bicycle to the car. Among only 10% of the former bikers’, speed is the reason for the switch.
- Partial abstraction from bike: comfort (45.1%), speed (25.1%) and a combination of both (16.1%) are the reasons to drive to the terminal rather than cycling.

Through field observations, the unintended effect ‘Park and walk users’ has been reported also for two facilities: Mariahoeve and Voorburg. The observations were made in the morning peak hours [07:00-09:00]. This unintended effect is very strong in both locations: 50.0% in Mairahoeve and an astonishing 81.0% in Voorburg. In both cases, many employees of two large companies located near the sites use the P&R facilities as a normal company parking lot<sup>25</sup>.

### *Transport and environmental effects*

In order to estimate the transportation and environmental effects of the P&R facilities, the same kind of postal code analysis made for Rotterdam has been performed. Table 4.5 shows the results. The outcome for the users that would have driven prior the introduction of the P&R has been split for traffic, with The Hague as a final destination and traffic with other

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<sup>25</sup> Interestingly enough, while this effect was unknown to the transport department of the Municipality of The Hague (the commissioner of the research), during an interview, the management of these companies clearly stated that the presence of the P&R was one of the reasons to be located in those areas and that a specific deal was reached with the Municipality [not that transport department] in order for their employees to make use of the P&R facilities.

cities in the Netherlands as final destination. The total reduction caused by the sample is equal to 869.9 VKT or 153.1 Kg of CO<sub>2</sub>. The extra VKT generated by the unintended effects abstraction from public transport, abstraction from bicycle and partial abstraction from bicycle amount to, respectively, 661.3, 32.3 and 88.1 VKT. The net effect caused by the 195 users that have been surveyed is a net reduction of 88.2 VKT or 15.5 Kg of CO<sub>2</sub>. In contrast with the case of Rotterdam, the use of P&R facilities in The Hague has a positive effect in terms of overall reduction of VKT and related vehicle emissions. This is mainly due to the different kinds of facilities in The Hague area. Most of them have indeed a remote function intercepting drivers close to their homes. This dramatically reduces the negative impact of the unintended effects.

**Table 4.5: Cumulative transport and environmental effects of the six P&R locations in The Hague**

	VKT	Emissions in Kg CO <sub>2</sub>	Emissions in g NO <sub>x</sub>	Emissions in g PM <sub>10</sub>
Reduction in car-km (only for travelers with direction The Hague)	- 70	-12.3	-21.7	-1.1
Reduction in car-km (for travelers with other directions)	-799.9	-140.8	-248.0	-12.8
<b>Total reduction in car-km (A)</b>	<b>-869.9</b>	<b>-153.1</b>	<b>-269.7</b>	<b>-13.9</b>
Extra car-km abstraction from public transport	661.3	116.4	205.0	10.6
Extra car-km abstraction from bike	32.3	5.7	10.0	0.5
Extra car-km partial abstraction from bike	88.1	15.5	27.3	1.4
<b>Total extra car-km (B)</b>	<b>781.7</b>	<b>137.6</b>	<b>242.3</b>	<b>12.5</b>
<b>Net change (B-A)</b>	<b>- 88.2</b>	<b>-15.5</b>	<b>-27.3</b>	<b>-1.4</b>

Finally, if a daily tariff of €3-4 for parking were introduced, less than a quarter of the respondents (22.3%) stated that they would still make use of the P&R (see Table 4.6), 11.4% would use a car to their final destinations, 16.6% would try to find a parking place somewhere else around the public transport terminal, 21.2% would use the public transport for the whole trip and 24.4% would use a bike to reach the public transport terminal or the final destination. On the one hand the introduction of a fee might reduce the unintended effects: 42.8% of the former public transport users would go back to the public transport for the whole trip, 70.0% of the former bikers would use the bike again for the whole trip and 65.6% of those that were used to bike to the terminal would do it again. On the other hand, the introduction of the fee would reduce also the positive effects of P&R: 47.2% of former motorists would drive to their final destinations, and 37.8% of the drivers that were parking the car around the terminal would do it again, possibly increasing the parking pressure in the area.

It is interesting to highlight that the introduction of a pricing policy would have no effect on those travelling for leisure: 100% of them would keep using the P&R, and none would abstain from going to the city because of the fee.

**Table 4.6: Reaction to the introduction of a daily fee of €3-4 by users of the P&R locations in The Hague**

	%
Continue to use the P&R	22.3
By car to the final destination	11.4
Park the car in the surrounding of the PT terminal	16.6
By public transport to the final destination	21.2
By bike to the final destination/ PT terminal	24.4
Not making the same kind of trip anymore	0.5
Do not know	3.6
<b>Total</b>	<b>100.0</b>

## 4.6 Conclusions

Previous research, mostly on UK bus-based P&Rs, has focused on the degree to which P&R policies are able to meet the goal of reducing overall car use. The aim of this paper was to build on this body of literature by empirically studying some the transport and environmental impacts of this popular transport infrastructure. While existing literature focuses mainly on bus-based P&R, this work analyses the use of rail-based P&R (tram, metro and train).

We conducted a users' survey (N=738) in nine non-bus-based P&Rs located around the cities of Rotterdam and The Hague in The Netherlands in 2008 and 2009. The analysis suggests three main findings that add to the existing knowledge on the topic: the observation of an additional number of unintended effects, the possible effect of the introduction of paid parking in the P&R site and the fundamental difference – in terms of transport and environmental impact – between remote and peripheral P&R locations.

Firstly, two new unintended effects have been identified, more specifically “abstraction from bike” [partial or total] and “Park and walk users”. The first refers to those users who, prior the introduction of the P&R facility, used to cycle either to the public transport terminal or to their final destinations. Even if this might be considered a phenomenon that is not equally relevant for most countries (the share of biking in the Netherlands is relatively high, as in Denmark), it should not be underestimated, especially considering the positive health effects of regular use of the bicycle. In addition, cycling is getting increasingly popular amongst policy makers, planners and travellers in many western towns, cities and regions. The second refers to those drivers using the P&R as a simple parking lot without making use of the public transport, mainly because the site is located in the proximity of their final destination.

Next, the introduction of a price for making use of the P&R facilities should contribute to reducing the magnitude of the unintended effects. Former public transport users and cyclists would return to their original way of travel when a parking fee is introduced. It is worthwhile mentioning that a pricing policy might also have two negative side effects: some of the intercept motorists would drive all the way to their final destination, thus increasing the overall car use, and some problems related to increase parking pressure in the adjacent areas might arise due to motorists searching for an alternative parking spot.

Finally, this paper highlights an important difference in the net impact of P&Rs in terms of VKT and vehicle emissions between remote and peripheral facilities. The use of peripheral

P&R leads to a negative net effect in terms of additional VKT and vehicle emissions. Because this type of P&R aims to intercept drivers just before their final destination, as the part of the journey made by car is generally larger than that made by public transport. This means that the magnitude of the unintended effects in terms of VKT and vehicle emissions is very large and, usually, not compensated by the reduction generated by reducing the total car trip of some of those users who would use a car to reach their final destinations. In other words, with peripheral P&R, the net reduction in car use caused by the intended effect seems to be more than compensated by the increase in car use caused by the unintended effects. On the other side, the use of remote P&R facilities seems to have a net positive effect. Due to the short distance between users' origin and the public transport terminal, the magnitude of the unintended effects is relatively low and does not outweigh the positive effect of the intended effect.

#### 4.7 Implications for policy

A number of policy suggestions can be drawn from this research. First, it is recommended that the use of P&R facilities should be regularly monitored. This seems to be necessary to understand whether they fulfil their original policy goals. Most, if not all, of the unintended effects are unavoidable, but their monitoring is essential to try, where possible, to reduce their magnitude by designing and implementing dedicated policies. In addition, results could be used for the design of new P&R facilities.

Second, paid parking should be taken into consideration when designing P&R policies. While it is not meant to fully recover the costs of the facility, it might be an important tool to regulate the unintended effects, especially the improper use. We consider a comprehensive parking policy for both the P&R area and the areas of the final destination as necessary. More specifically, if there is no form of parking management in the surrounding area of the facility, drivers will avoid the fee by parking in the proximity of the P&R. The fee should be competitive with respect to the parking fee on the final destination, otherwise motorists might prefer to continue their car trip until they arrive downtown.

Third, if the final aim of the policy is to reduce overall car use, remote P&R locations should be preferred to peripheral ones. Not only would the magnitude of the unintended effects be lower, but by intercepting the motorists at an early stage, the car part of the chain trip is reduced in favour of the public transport part. This result is in line with previous policy suggestions made by Parkhurst (2000b) and Meek et al. (2011).

P&R policy is usually part of the [local] parking policy, on its turn part of the [local] transport strategy. All in all, a comprehensive approach to P&R is needed in order for policy to achieve the general goal of overall reduction in car use. This might go beyond the sphere of influence of local authorities and require a more regional policy approach that includes also the major public transport operators like railways and interurban coach services.



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## 5 Residential visitor parking permit: the case of The Hague<sup>26</sup>

### 5.1 Introduction

Parking is an important element for both mobility and quality of life in urban areas. Parking policy, which is a matter for the local authority in almost any country, is often a delicate political issue. Policy debates and public consultations on parking-related topics are usually dominated by emotions and feelings and are seldom based on evidence and/or facts (Bates, 2014). Among others, residential parking is an upcoming issue in many towns and cities (Marsden, 2014). Despite the recognised high costs for parking supply in urban areas (Shoup, 2005), local authorities tend to charge very little for residents' parking (Manville, 2014; van Ommeren, de Groote, & Mingardo, 2014). The logic behind this policy is often the idea that residents pay taxes to the local authority and, accordingly, have the 'right' to park their car for free or for a small fee. Manville (2014) refers to this issue as the concern of 'double taxation'. Critics of parking pricing argue that motorists have already paid for parking spaces through property taxes and that forcing them to pay again for the use of parking is unfair.

While the vast majority of literature on parking focuses on destination-end parking, research on residential parking is scarce. Guo (2013a) investigated the effect of residential parking on car ownership in the city of New York and suggests that parking supply has a significant influence on car ownership decisions. Apparently, residential parking supply is even more influential than household income and composition on the decision whether to own a car. Using the same data, Guo (2013b) also analysed the effect of residential parking supply on households' car usage. He found that residents without off-street parking use their car less than those with off-street parking, suggesting that home parking convenience stimulates car use. Li and Guo (2014) studied the early 2000s parking reform in London (UK) in which the local authority replaced minimum parking standards for residential developments with maximum standards. The authors found that the reform led to a dramatic reduction of the number of parking spaces per unit of residential development, providing strong evidence that minimum parking standards do have a market distortion effect. Van Ommeren et al. (2014) also contributed to the debate on market distortion by estimating the welfare losses of policies that provide very cheap on-street parking permits to residents in downtown areas in the

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<sup>26</sup> This chapter is at the moment of writing this PhD thesis submitted for review.

Netherlands. Molenda and Sieg (2013) added to this debate by modelling the trade-off between privileged on-street parking for residents and the economic vitality of a city district. Their analysis suggests that the provision of privileged parking for residents is unlikely to result in a first-best allocation of urban space. Finally, Marsden (2014) addressed some of the most important issues regarding residential parking, suggesting it is a complex decision-set for policy makers. He advocates a parking policy with a broader vision that fully integrates land-use planning.

This paper adds to the scarce literature on residential parking by discussing the issue of visitor parking permits for residents<sup>27</sup> — i.e. the possibility for residents living in areas with paid parking to buy a number of (free or very cheap) parking hours that can be used for their visitors in a way that they do not have to pay for on-street parking. We focus on the city of The Hague in the Netherlands. To the best of the authors' knowledge, this is the first attempt to study this specific aspect of residential parking policy. In the Netherlands, this scheme is already in use in all major cities and towns, and similar systems exist in other European countries. As such, we think it is useful to have insight into the effects of this kind of policy. Other cities might learn useful information from the outcome of this study.

The rest of the paper is organised as follows: section 5.2 presents the context regarding the case object of this study. Section 5.3 describes the methodology used, and section 5.4 shows the main results. Finally, section 5.5 discusses the main conclusions, and section 5.6 presents some policy recommendations.

## 5.2 Background and aim of the research

In order to manage car travel demands, the vast majority of large cities in the Netherlands apply active parking management schemes - mostly paid parking and/or time restrictions - in their central areas. These policies are usually meant for non-residents, i.e. visitors and/or commuters. In particular, parking fees are used to manage non-residential car usage. Residents of the urban districts with on-street paid parking can apply for a parking permit. This permit is usually very cheap, at least for the first car, and allows residents to park their cars in a specific area without paying the on-street fee. As suggested by van Ommeren et al. (2014), such a cheap residential parking permit is inefficient from an economic point of view because it induces a welfare loss that increases the cost of parking supply. However, economics might not be the only principle that guides local authorities when implementing transport policies (Feitelson & Salomon, 2004). Additionally, transport policy is often used for purposes other than transport, such as the promotion of regional development, employment, or other social objectives (Blauwens, De Baere, & Van de Voorde, 2008; Mallard & Glaister, 2008). The residential visitor parking permit might be seen as an example of such a social policy. It allows residents living in areas with paid parking to buy a number of free or very cheap parking hours to be used for their visitors in a way that they do not have to pay for parking.

In the city of The Hague, residents living in areas where on-street paid parking is enforced can buy a visitor parking permit for an annual fee of about €18. The permit contains a certain number of hours for visitor parking. The permit can only be used for on-street parking in the district where the residents live. The number of available parking hours per year depends on

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<sup>27</sup> In other cities, this concept might be known as 'short-term permits for residents' visitors', although most people refer to it simply as visitor parking permits.

the time span of on-street paid parking, implying the principle that more ‘visitor hours’ are granted for residents living in areas with a larger time span for on-street paid parking. In order to use the permit for a visitor, the resident has to ‘check-in’ his or her visitors upon arrival and ‘check-out’ when they leave. The procedure to check-in and out can be done by phone or Internet. In case the visitors overstay the time span of on-street paid parking, the system automatically checks them out (e.g. if a visitor arrives at 6:00 pm and stays until 9:00 pm in an area where paid parking is active until 8:00 pm, then the system will automatically stop charging hours on the resident’s permit at 8:00 pm). If a resident uses all hours of the permit before the end of the calendar year, his or her visitors have to pay the regular on-street parking fee. If a resident has not used all the available hours at the end of the calendar year, he or she is not allowed to transfer the saved hours to the next year. Consequently, the number of available hours per resident permit is fixed and equal per year for every permit holder living in the same district.

The city of The Hague is not the only Dutch city using a residential visitor parking permit scheme. Table 5.1 presents an overview of the cost per hour and the maximum number of hours per year for some major cities in the Netherlands. The cost per hour in The Hague is low in comparison to other cities. Relative to the other three large cities in the Randstad (Amsterdam, Rotterdam, and Utrecht), The Hague offers the cheapest rate per hour. The number of available hours is slightly lower than other cities. It is not possible to buy additional hours or to transfer any remaining hours to the next year in any of the cities included in the table.

**Table 5.1: Comparison of residential visitor parking permit systems in some major cities in the Netherlands in 2012**

City	Cost per hour (in €) <sup>28</sup>	Maximum number of hours per year
The Hague	0.07–0.16	115–277
Rotterdam	0.28	500
Amsterdam*	1.10–5.00*	No maximum
Utrecht	1.17–2.13	280
Leiden	0.44–0.63	200
Dordrecht	0.36	180
Groningen	0.02–0.04	832–1,300
* Amsterdam does not have a specific system for residential visitor parking. Visitors pay the normal price for on-street parking.		

Despite the fact that compared to other cities, the visitor permit system in The Hague seems favourable, a group of residents made an official inquiry to the local authority in 2011. They claimed that the number of hours for their visitors was too low, especially for some senior residents who might depend on other family members to visit them for care purposes. In response to the inquiry, the municipality of The Hague decided to research the use and perception of the residential visitor parking permit system. The main purpose of the research was to provide information to local policy makers about the use of the system in order to modify the policy if necessary. More specifically, the focus of the research is to get a better understanding of the following:

- a) the use rate of the permit (i.e. how many residents make use of it);

<sup>28</sup> The cost per hour is calculated by dividing the yearly fee for the total number of available hours.

- b) the magnitude and the location of the problem of not having enough hours (i.e. how many residents use 100% of the time available before the end of a calendar year);
- c) the users' perception of the system.

In this paper, we present the most important outcome of this research. The case of The Hague can be seen as an example of how to deal with residential visitor parking permit systems in other cities. The results of this study can be useful to other cities that apply similar schemes.

### 5.3 Methodology

Due to the lack of preliminary research in the area of residential visitor parking permit, this study makes use of an exploratory case study approach (Robson, 2002). We combine both a quantitative and a qualitative method. The quantitative analysis consisted of two parts: (1) a data analysis of the parking transactions related to the permit scheme and (2) a survey among the residents who have the permit (N=1,153).

In order to use the permit, the resident must register the arrival and departure of his or her visitor with a 'check-in/out' system via Internet or phone. Accordingly, all transactions made by the residents are registered in a central database. In total, more than 2.8 million parking transactions have been analysed for the period from February 2007 — when the measure was first introduced in a number of districts — until June 2012.

The visitor permit has been introduced over different years in 25 districts of the city (Figure 5.1). Three districts (19, 35, and 36) were added after the research was carried out (July–December 2012) and are thus not included in the analysis. The time span of the available data varies per district: more than one year for 8 districts, one year for 11 districts, and less than one year for 3 districts. The 3 districts (18, 22, and 30) in which data is available for less than one year have been excluded from the analysis because the permit has a yearly duration.

An online survey was used to collect additional information on the use of the permit and on the perception about the user-friendliness of the system. The local authority approached approximately 5,000 people to participate in the survey, and 1,153 respondents filled it in (1,020 online and 133 by mail), implying a response rate of about 20%. According to Sauermann and Roach (2013), this is the upper part of the bandwidth of the response rate for detailed online surveys.

The qualitative analysis consisted of three focus groups with residents (each with 10 participants) and was used to integrate the outcome of the quantitative analysis. Kitzinger (1995) and Morgan (1996) suggest that focus groups are useful for exploring and/or explaining survey results. The participants were selected among the residents who filled in the survey, considering differences in age, gender, and district.

Table 5.2 provides an overview of the links between the methodology used and the aims of the research as described at the end of section 5.2.

**Table 5.2: Link between the research aims and the methodology used**

Aim of the research	Methodology		
	Quantitative – data analysis	Quantitative – survey	Qualitative – focus groups
1) To get better insight into the use of the permit	*	*	
2) To understand the magnitude and location of the problem of not having enough hours	*		
3) To gain knowledge on how residents perceive the system		*	*

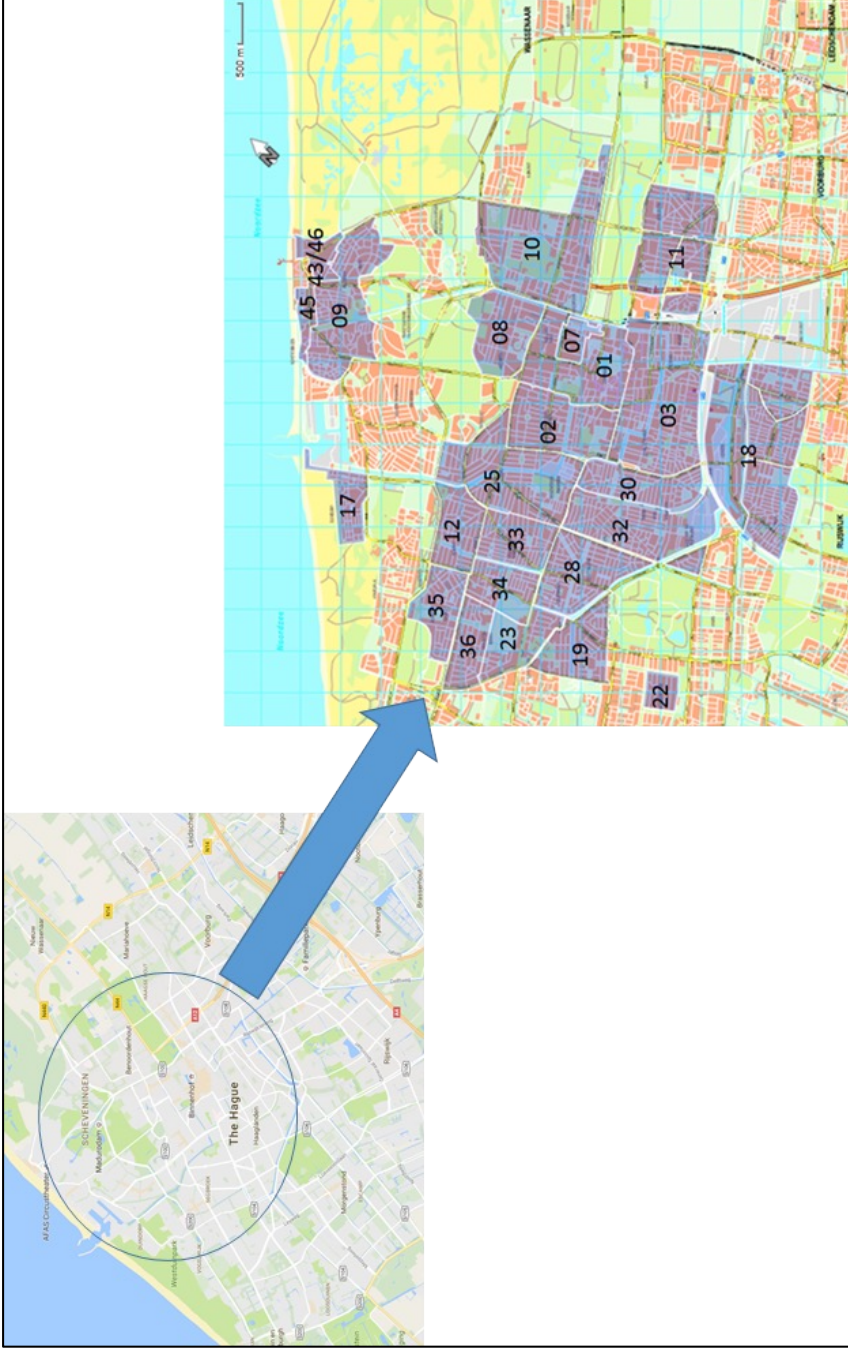


Figure 5.1: Residential visitor parking permit zones in The Hague (2015)



**Table 5.3: Overview of the main outcomes of the dataset analysis**

District	Paid parking time	Number of permit holders	% used permit at least once <sup>29</sup>	% used ≥100% of hours	% used ≥90% of hours	% used ≥80% of hours
1	Mon-Sat 9:00-24:00 & Sun 13:00-24:00	1,280	83.13%	1.03	11.37	15.88
2	Mon-Sat 9:00-24:00 & Sun 13:00-24:00	4,426	87.03%	1.35	14.69	20.28
3	Mon-Sat 9:00-24:00 & Sun 13:00-24:00	7,866	81.78%	1.35	9.39	12.79
7	Mon-Sat 9:00-24:00 & Sun 13:00-24:00	499	84.57%	2.37	12.02	15.57
8	Mon-Sat 9:00-17:00	1,617	81.76%	3.78	18.61	22.62
9	Daily 10:00-24:00	1,705	92.67%	1.77	18.35	24.24
10	Mon-Sat 9:00-17:00	3,465	82.40%	2.00	7.60	12.96
11	Mon-Fri 9:00-14:00	2,746	80.52%	3.39	15.73	19.07
12	Daily 18:00-24:00	2,492	73.94%	0.54	16.51	21.49
17	Daily 10:00-24:00	2,060	84.63%	1.94	16.89	21.73
18 <sup>30</sup>	Mon-Fri 9:00-22:00 or 9:00-18:00 + Thu 18:00-21:00	590	79.32%	42.95	45.48	48.47
22	Mon-Sat 9:00-18:00 & Thu 18:00-21:00	278	74.82%	14.90	16.82	19.70
23	Daily 18:00-24:00	2,690	71.13%	17.21	20.62	24.52
25	Daily 18:00-24:00	5,616	71.75%	0.54	16.25	20.80
28	Daily 18:00-24:00	4,678	67.04%	0.63	21.95	27.57
30	Mon, Wed, Fri, Sat 9:00-18:00; Tue, Thu, Sun 18:00-24:00	4,065	78.89%	26.88	30.81	35.83
32	Mon, Wed, Fri, Sat 9:00-18:00; Tue, Thu, Sun 18:00-24:00	4,458	73.17%	20.21	23.94	28.76
33	Daily 18:00-24:00	3,011	76.05%	0.61	21.81	26.83
34	Daily 17:00-21:00	766	80.94%	1.26	11.65	16.38
43	Daily 10:00-24:00; Sat/Sun 24:00-2:00	1,010	87.13%	1.36	10.91	15.12
45	Daily 10:00-24:00	1,828	90.81%	1.75	18.44	24.10
46	Daily 10:00-24:00	34	94.12%	0.00	3.13	6.26
	<b>Total</b>	<b>57,180</b>				
	<b>Average</b>		<b>81.29%</b>	<b>3.27%</b>	<b>15.26%</b>	<b>19.84%</b>

<sup>29</sup> When data are available for multiple years, the weighted average has been used.<sup>30</sup> Excluded from analyses due to limited time span

## 5.4 Results

### *Data analysis*

Table 5.3 provides an overview of the main outcomes of the data analysis. Considering all districts included in the analysis, about 81% of the permit holders — i.e. the residents who apply for the visitor permit — used the permit at least once within the selected period. This implies that almost one-fifth of the permit holders did not use the permit at all despite paying for it. In order to understand the magnitude of the residents who might face the problem of having too few hours for their visitors, we compared the amount of hours used by permit holders with the maximum number of hours they have available. The percentage of permit holders who use 100% of the available hours is relatively high only in districts 23 and 32 (17% and 20%, respectively). In all other districts, only a small percentage of permit holders use the total amount of hours. At the city level, an average of 3.27% of permit holders makes use of all available hours. If we consider the percentage of permit holders who have used at least 90% or 80% of the maximum number of hours available<sup>31</sup> the average for the whole city rises to 15.2% and 19.8%, respectively, of the permit holders. Furthermore, we noticed that in many districts, between 50% and 70% of permit holders use less than 50% of the total number of hours. This might suggest that for a large portion of the residents the total amount of hours available per year is more than enough.

A further analysis of some socio-economic characteristics of districts 23 and 32 (Table 5.4) suggests that these two districts are not particularly different from the city average for aspects that might influence the use of the visitor parking permit. For example, the percentage of elderly people — a group that might depend more on the visits of family members for care purposes — in both districts is not higher than the average for the city of The Hague.

**Table 5.4: Socio-economic characteristics of districts 23 and 32 relative to the average of the city (source: [www.cbs.nl](http://www.cbs.nl)).**

	District 23	District 32	Average city The Hague
% of population 65 years-old or older	18	8	18
% of households with children	28	37	27
Car ownership per household	0.70	0.50	0.77
% of households with low income	50	67	45

**Table 5.5: Distribution of options to check in and out of the system (%).**

Option	Check-in	Check-out
Internet	16	9
Telephone	84	60
Automatic logoff	-	31
<i>Total</i>	<i>100</i>	<i>100</i>

<sup>31</sup> There might be reasons to believe that when permit holders approach 80–90% of the total usage, they might decide to use the permit less often in order to keep a kind of ‘safety reserve’.

**Table 5.6: Distribution of the check-ins throughout the week (%).**

Day of the week	Percentage check-in
Monday	13
Tuesday	12
Wednesday	15
Thursday	13
Friday	16
Saturday	17
Sunday	14
<i>Total</i>	<i>100</i>

Table 5.5 shows how permit holders check in and out of the system. The vast majority of check-ins are made by telephone (84%); for the check-outs, the telephone is still the most used option (60%), but almost one-third of all transactions are ended by automatic check-out. This automatic check-out procedure occurs at the end of the on-street paid parking period when the visitors overstay this time span (e.g. if paid parking is active until 18:00 and a visitor stays longer, then the system automatically checks out at 18:00). This happens relatively more often during the weekends; about 46% of automatic check-outs happen on Friday, Saturday, and Sunday, probably suggesting visitors stay longer or overnight. Another explanation might be that permit holders either forget to check-out their visitors or simply might not do it because of indolence<sup>32</sup>. The fact that most check-ins and check-outs are made by phone has an important financial consequence for the local authority; since the telephone number that residents must call is free for the users, the telephone costs are paid by the municipality. In 2012, these costs were very high, averaging €40,000 per month, implying that approximately half of the permit revenue is used just to cover the telephone costs<sup>33</sup> (Mingardo & Streng, 2013). Table 5.6 shows that the use of the visitor permit is relatively equally distributed throughout the week.

### **Online survey**

The online survey gives additional information regarding the use of the visitor permit with regard to the perception, experience, and opinion of the users (i.e. the residents). It provides the kind of information that is difficult to retrieve from the data analysis of the parking transactions. The questionnaire was set up in accordance with senior policy makers of the city (see Appendix). The main outcomes of the survey are the following:

- Approximately one-third of the respondents (31.8%) did not know the total number of parking hours they have available in their own districts.
- About 37% of the respondents did not know the remaining amount of hours available on their permit at the moment of filling in the survey.
- The opinion about the total available hours per year was evenly divided: about 47% of the respondents consider the amount of hours just sufficient or more than sufficient for their needs, whereas about 47% think they are just insufficient or more than insufficient. This is in clear contrast with the findings of the data analysis, which is described in the beginning of this chapter, in which the percentage of permit holders

<sup>32</sup> If, for example, your visitors are leaving just 30 minutes before the end of the paid parking period, you might decide it is not worthwhile to start the check-out procedure.

<sup>33</sup> The total yearly revenue is just above one million euro ( $€57,180 \times 18 = €1,029,240$ ) and the costs almost half a million ( $€40,000 \times 12 = €480,000$ ).

who use all hours is very low. Even when we consider the permit holders who use 80% or 90% of the total available hours, there is still a substantial difference. A possible explanation might be that the people who filled in the online survey are those who 'have something to complain about'. The survey was promoted officially via the website of the local authority, and this might be used as a means to complain. Those who do not have any problem with the system probably would not be interested in spending their time filling in a survey. Accordingly, the data of the online survey might be partially biased towards a negative evaluation of the system.

- If the local authority introduced the possibility to buy additional parking hours for the permit (above the yearly maximum) against the actual on-street hourly parking fee, about 58% of the respondents would not use this option; about 19.4% would use it, and about 22.6% would think about it.
- The majority of the respondents (about 89%) are aware of the automatic check-out option of the system.
- The three most important types of visitors for which the permit is used are family members, friends, and partners. Yet, the permit is often used for customers (18%) and for the parking permit holder's own car. Clearly, the last two purposes are not in line with the original policy aim of the local authority.
- Almost 60% of the users consider the procedure for requesting a permit good or reasonable; 51.6% of the respondents have the same judgment for the check-in/out procedure by phone and 32.6% for the Internet option. The latter is characterised by the fact that more than a third of the respondents have no opinion. This might be partially explained by the fact that the Internet is used only for a minority of check-ins and check-outs (see Table 5.5).
- Finally, more than half of the respondents (52%) think that the check-in and check-out procedure would improve with a mobile app.

### ***Focus group***

At the end of the online survey, respondents were invited to take part in a focus group in order to further discuss some issues concerning the residential visitor parking permit. In total, 156 people applied for the focus group. Three focus groups took place a few weeks after the online survey for a total of 30 participants. Residents were selected based on the district of residence, gender, and age in order to have a representative sample for the whole city.

The main outcomes of the focus groups are the following:

- Many residents do not understand why the local authority does not allow them to transfer the unused hours at the end of a year to the next year.
- The system is considered too complex and old-fashioned, making it difficult to use. This might especially be the case for older people.
- Participants would prefer a more flexible system, such as the possibility to buy additional hours or to check-in multiple visitors at the same time. Actually, the possibility to check-in more visitors at the same time already exists, but, apparently, the participants of the focus groups did not know.
- Finally, several participants suggested that the introduction of a mobile app to check-in and out would enhance the quality and user-friendliness of the system.

## 5.5 Conclusions

In 2007 the city of The Hague introduced the residential visitor parking permit, i.e. the possibility for residents living in areas with paid parking to buy a number of parking hours for a very small fee to be used for their visitors in a way that they do not have to pay for on-street parking. In 2011, a group of residents made an official inquiry questioning the functioning of the policy, mainly suggesting that for a large number of residents — especially elderly people who might rely more on social visits for care — the permit does not have enough hours. In 2013, the local authority decided to perform a study on the use of the permit in order to, eventually, improve the policy. Table 5.2 gives an overview of the main aim of the research. In this section, we summarise the most important outcomes of the study.

Regarding the use of the permit, we notice that in 8 of the 21 districts analysed, more than 20% of the residents never use the permit, even if they bought one. While we can only speculate on the reasons why residents do not use the permit, we can be sure that this behaviour is costly for the local authority. Indeed, the €18 fee paid by the residents to obtain the permit covers just a fraction of the costs incurred by the local authority to provide the permit. Only considering these 8 districts, we counted more than 7,000 inhabitants who have asked for a service they do not use. The very low fee that must be paid probably stimulates people to ask for such a permit even if they rarely need it. A higher fee might work as a threshold where people think more carefully whether they need such a service.

If we consider as a potential problem those residents who use 100% of the amount of hours available on the permit within a calendar year, then we see that the percentage of inhabitants citywide who have a problem is relatively low (3.27%). If we consider the residents who use 90% or 80% of the amount of hours available on the permit, then the average increases substantially — 15.2% and 19.8%, respectively — but still less than one-fifth of the residents might have a problem. This suggests that there is probably no need to increase the number of hours, but it might be wise to add some degree of flexibility. For example, there could be the option to buy additional hours for those residents willing to do so, or different packages (small, medium, extra) could be offered at different prices. After all, we know that in many districts the majority of permit holders use less than half of the available hours, suggesting they might be interested in buying a smaller package.

Finally, the survey and the focus groups suggest that the quality of the system and its user-friendliness might be improved through better communication and, most probably, with the use of a mobile app. The former might help residents to understand the (policy) rationale behind the permit, and the latter might simplify the check-in and check-out system; make the use of existing functions easier, like the possibility to check in more visitors at the same time; and substantially reduce the telephone costs for the local authority. Additionally, through the use of a mobile app, it might be easier to introduce different packages for residents as mentioned above. At the time of writing this paper (2015), there is still no mobile app available.

## 5.6 Implications for policy

We can identify three main policy implications as outcomes of this paper. The first is that the use of data can help policy makers in the debate with citizens, especially on such an emotional topic as parking. Rather than relying on feelings and emotions, data can provide policy

makers with objective information to frame the discussion. In this specific case, the analysis of data suggests that there is no need to drastically change the policy because of the citizens' inquiry. Minor changes to the policy might be enough. There is a clear difference between the perception of the problem and the real situation. The quantitative analysis of the dataset suggests that the number of users who do not have a sufficient number of hours is relatively limited (3.27% citywide). Moreover, data suggest that in many districts more than half of the permit holders use less than 50% of the available hours. These results are in contradiction to the assumption of the residents who made the official inquiry claiming that many people have a problem with an insufficient number of hours.

Next, the gap between perception and reality might be bridged by means of better communication by the authority. For example, while the logic of paid parking might be known to (most) policy makers, it might not be obvious to citizens. Clear and adequate communication regarding the functioning of the system and the objectives of the policy might increase citizens' acceptance. Quick wins in terms of increased user-friendliness and decreased managing costs can be realised with the introduction of a mobile app.

Finally, the local authority might consider customising the visitor permit on the basis of residents' needs. Instead of offering a 'one-size-fits-all' permit — i.e. all residents in the same district get the same amount of hours per year for the same price — the municipality could offer different kinds of permits (e.g. small, medium, large) at different fees. In this way, residents who expect to receive more visitors could have more parking hours on the permit. Although this study is based on the specific residential visitor parking permit scheme of the city of The Hague (the Netherlands), we believe the outcome is interesting for policy makers in other cities that deal with similar measures.

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## Appendix

The question list below has been translated from Dutch. The possible answers are included in brackets.

1. How many cars are available in your household? [0, 1, 2, more than 2]
2. Do you have a residential visitor parking permit? [yes, no]
3. Do you know approximately the number of hours per year that are available on your permit? [No; Yes, approximately...]
4. Do you know approximately how many hours you still have available at this moment? [no; yes, approximately...]
5. What is your opinion about the total number of hours available per year per permit? [more than sufficient, sufficient, not sufficient, far insufficient, don't know]
6. Are you aware of the automatic check-out option? [yes, no]
7. Do you manually check out your visitors? [always, sometimes, rarely, never]
8. When do you use the parking permit? [mostly during the week, mostly on the weekend, both during the week and on the weekend]
9. For which group do you make use of the permit? [family members; friends; partner; customers; to park my own car; other, namely...; no specific group; don't know]
10. How do you evaluate the process of requesting the permit? [very good, good, neutral, bad, very bad, don't know]
11. How do you evaluate the user-friendliness of the check-in and check-out procedure through the Internet? [very good, good, neutral, bad, very bad, don't know]
12. How do you evaluate the user-friendliness of the check-in and check-out procedure through the phone? [very good, good, neutral, bad, very bad, don't know]
13. Would the introduction of a mobile app facilitate the check-in and check-out procedure? [yes, no, I don't know]
14. What are the four digits of your zip code?
15. What is your age category? [18–34, 35–49, 50–64, 65–80, 80+]



## 6 Conclusions

This chapter presents and discusses the main outcomes of the research. First, I summarize the findings and conclusions of each of the research papers. Second, I discuss the contribution and the transferability of the findings to the scientific research on parking. Next, I consider the implications for policy makers. The chapter concludes with recommendations for further research on parking.

### 6.1 Summary of the findings

Parking is an important and complex policy instrument for urban planners and policymakers. In this thesis I made an attempt to shed more light on some of the major issues concerning parking policy. More specifically I tried to reduce the knowledge gap on parking by:

- Providing a general framework for the development of parking policy in European urban areas (chapter 2);
- Studying the specific issues of the relationship between parking and retail (chapter 3), the effects of rail-based P&R facilities (chapter 4) and the use of a residential visitors parking permit system (chapter 5).

#### *Chapter 2 – Urban parking policy explained*

This chapter deals with the general development of parking policy, i.e. how parking policy has evolved in the last decennia. This is an important topic for policy makers because it provides them with a framework in which parking policy should be developed. The main research question addressed in this chapter is: “how does parking policy develop in urban areas?” with a specific focus on European cities.

The chapter aim is twofold: first to conceptualize parking policy in Europe, i.e. to propose key aspects of parking policy and a generic description of how it evolves; second, to contribute to the discussion on the future of parking policy in European cities, by proposing a new approach for it. The methodology used for this paper is inspired by grounded theory (Glaser, 1992). The authors use grounded theory as a way of developing a new theory.

In this chapter I argue that most European cities follow more or less the same pattern when it comes to parking policy (figure 2.1). Within this pattern one can distinguish three phases, each of them consisting of one of more stages:

- Phase one: the rise of parking regulation. At the very beginning of urban development when car ownership is extremely low and/or there is abundant space in the city any form of parking regulation is absent. As the level of car ownership and traffic increase, cities start to introduce the first form of parking regulations and control mainly in the busiest areas of the city center. In certain areas parking is prohibited and in other areas parking spaces are clearly marked. Still, most of the parking capacity is on-street and free of charge. As pressure on the available parking spaces increases, time restrictions are introduced in the busiest streets or parts of the city (i.e. CBD and main shopping areas). Parking enforcement is introduced in this stage. This kind of policy stimulates short stay parking and is often introduced to maximize the number of visitors (usually shoppers) to the central area.
- Phase two: the advent of pricing parking. Rising urban density, welfare and car ownership boost car use in urban areas increasing the parking problem. The demand for parking space clearly exceeds the supply causing congestion – both to enter the city centre and to search for a parking space – and illegal parking. In order to reduce these problems and to regulate demand, parking fees are introduced initially in the city centre. The introduction of paid parking is sometimes accompanied by the introduction of residents’ and/or working parking permits. The enforcement activities increase accordingly. In this stage parking standards, in some countries suggested or required by national authorities, are regularly applied to new development project in the urban areas. As time goes on the area where pricing parking is active is usually extended in order to prevent the typical “spillover effects”, as described by Ison and Rye (2006). In some cities this stage is also characterized by the increased use of off-street, often underground, parking facilities.
- Phase three: parking policy as integral part of TDM strategies. Phases one and two are characterized by a reactive parking policy. Policy makers simply introduce specific parking measures in reaction to the rise of a specific problem. The different stages of development in these two phases simply follow each other. In this phase parking becomes an integrated part of transport demand management practices (Litman, 2006; Ison and Rye, 2008) and gets a higher rank on the urban political agenda and in the planning process. A broader vision on parking emerges where parking is more integrated with the general aims of the city in terms of mobility, urban planning and environmental quality. In this phase the shift in policy from “command & control” to “managing demand” takes place. Besides a further extension of the priced areas on-street, some new measures are introduced, the most important being: supply restraint; Park and Ride (P&R) facilities; differentiated parking pricing; the introduction of multiple use of parking space; and workplace parking levies.

Nowadays, most cities and towns in Europe have entered (or are entering) the third phase. In most of them there is a tension between the reactive/operational approach to managing parking, typical of phase one and two, and the more strategic, evidence based approach necessary for phase three.

### ***Chapter 3 – Parking and Retail***

In chapter three I discuss a hot societal issue, namely the importance of parking for the retail sector. The research question underlying this chapter is: “is parking supply related to turnover of shopping areas?”

Normally speaking, shop owners, retail managers and branch organizations strongly believe that parking plays a fundamental role in the performance of shopping areas. The dogma “no

parking, no business” is often used to describe the retail sector’s point of view. Accordingly, local authorities are often under pressure in order to provide additional parking capacity and/or reduce or freeze parking tariffs in and around shopping areas, even in busy downtown locations. The aim of this chapter is to test whether the general dogma of the retail sector “no parking, no business” is correct. The authors use a set of different data on 80 major shopping areas in The Netherlands to discuss, by means of a multiple (loglinear) regression analysis, the influence of parking on retail turnover.

The outcome of the statistical analysis suggests three major results:

- a) First, there is a positive significant relationship between parking tariffs and turnover per square meter of sales floor surface (SFS m<sup>2</sup>). This outcome suggests that higher parking fees are associated to higher turnovers per SFS m<sup>2</sup> in shopping areas, in contrast to what is generally believed by retailers. Although this might seem strange, it is reasonable to assume that the highest levels of turnover per SFS m<sup>2</sup> correspond to the most attractive shopping areas, those that attract most customers. In these shopping areas customers compete for parking that, independent of the type of shopping area, is always a scarce good and, ergo, can be charged.
- b) Second, considering the whole database, the supply of parking has no influence on turnover of shopping areas. Once more, this is in contrast to the dogma ‘no parking, no business’. The success of a shopping area most probably depends on its attractiveness, which, in turn, might depend on several factors such as quantity and quality of the shops, visitor-friendliness, location, accessibility, etc. The analysis performed in this chapter suggests that the number of parking places available in a shopping area might not be one of these factors.
- c) Third, specifically for the category ‘regional shopping areas’ – i.e. between 100 and 400 shops – there is a significant positive relationship between parking capacity and turnover. Given their specific nature, these kind of shopping areas tend to attract visitors from a wide area and this might explain why the possibility to use the car has an influence on turnover. In this case the findings are in accordance to the retailers’ philosophy, though the model explains only 28.6% of the variation in turnover. For these shopping areas an elasticity level of 0.26 has been found, meaning that an increase of 1% of the parking capacity leads to an increase in 0.26% of the turnover per m<sup>2</sup>.

#### ***Chapter 4 – Rail-based Park and Ride***

The fourth chapter of the thesis discusses the transport and environmental effects of rail-based P&R. Research on P&R is important for policy makers because these special kind of parking facilities have often negative side effects that should be seriously considered. The research question is: “what are the transport and environmental effects of rail-based P&R?” For answering this question I analyze the use of nine P&R facilities in Rotterdam and The Hague.

This chapter makes use of the results of a users’ survey (N=738) conducted within nine rail-based P&Rs located around the cities of Rotterdam and The Hague in The Netherlands. The main aim of this survey was to understand the impact of this popular transport infrastructure in terms of vehicle km travelled (VKT) and emissions (CO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub>). The paper builds on the work of Parkhurst (1995; 2000a) and Meek et al. (2009; 2010; 2011) and adds empirical evidence that might contribute to a better understanding of the impact the different types of P&R might have on travel behavior and car use.

The analysis suggests three main findings that add to the existing literature on P&R:

- a) First, two new unintended effects have been identified, more specifically “abstraction from bike” [partial or total] and “Park and walk users”. The first refers to those users who, prior the introduction of the P&R, used to cycle either to the public transport terminal or to their final destinations. The second refers to those drivers using the P&R as a simple parking lot without making use of public transport, mainly because the site is located in the proximity of their final destination.
- b) Second, the introduction of a price for using the P&R facilities should contribute to reduce the magnitude of the unintended effects. Former public transport users and cyclists would return to their original way of travel when a parking fee is introduced. It is worthwhile mentioning that a pricing policy might also have two negative side effects: some of the intercept motorists would drive all the way to their final destination, thus increasing the overall car use, and some problems related to increase parking pressure in the adjacent areas might arise due to motorists searching for an alternative parking spot.
- c) Third, there exists an important difference in the net impact of P&Rs in terms of VKT and vehicle emissions between remote (with an origin function) and peripheral (with a destination function) facilities. The use of peripheral P&R leads to a negative net effect in terms of additional VKT and vehicle emissions. Because this type of P&R aims to intercept drivers just before their final destination, the part of the journey made by car is generally larger than that made by public transport. As a consequence, the extra VKT and vehicle emissions generated by the unintended effects are usually not compensated by the reduction in car trip length of those users who would, without P&R, use a car to reach their final destinations. On the other side, the use of remote P&R facilities seems to have a net positive effect. Due to the short distance between users’ origin and the public transport terminal, the magnitude of the unintended effects is relatively low and does not outweigh the positive effect of the intended effect.

### ***Chapter 5 – Residential visitor parking permit***

Chapter five addresses a new topic in the parking literature, namely residential visitor parking permits. Such a permit consists in the possibility for residents living in areas with paid parking to buy a number of parking hours for their visitors, usually for a very low fee. The focus of the study is the city of The Hague in the Netherlands and the research question is “What are the most important insights in the use of a residential visitor parking permit in the city of The Hague?”

In this chapter, the authors make use of both a quantitative and qualitative research. The first includes the analysis of more than 2.8 million parking transaction related to the permit scheme over a five-year period (2007-2012), and a survey (N=1,153) among the residents holding the permit. The latter, consists of three focus groups with residents (10 participants each) and it is used to integrate the outcome of the quantitative analysis.

The most important findings of this study are the following:

- a) First, a relatively large number of residents never used the permit despite buying it. In some districts of the city, this is more than 20% of the permit holders. Considering the fact that the price of the permit (€18) covers just a fraction of the costs incurred by the local authority, the practice of requesting a permit and not using it might be quite costly for the local authority. A higher fee might work as a threshold for people to think more carefully whether they need such a service or not.

- b) Second, citywide the percentage of residents that might have a problem in terms of not having enough hours – i.e. those using 100% of the available hours – is relatively low (3.27%). This suggests that probably there is no need to increase the number of hours, but it might be wise to add some degree of flexibility in the system. For example, different packages (small, medium, extra) could be offered at different prices.
- c) Finally, the survey and the focus groups suggest that the quality of the system and its user-friendliness might be improved through better communication and, most probably, with the use of a mobile app.

## 6.2 Scientific contribution and transferability of the findings

Each chapter of this thesis deals with a different aspect of parking policy. In this section, I briefly discuss the scientific contribution and the transferability of the findings to the scientific literature on parking. Considering the importance and complexity of parking policy (see section 1.2) I give more attention on the transferability of the findings.

Chapter 2 provides an important contribution to theory formulation in parking and despite being based on the European planning experience it probably also explains the development of parking policy in several non-European cities. While there are important cultural and planning differences in terms of car use in different continents, I believe these might simply explain the pace at which cities move from one stage to the other, but they don't significantly change the pattern of development. For example, if European cities took some decades to move from phase one to phase three – and some are not yet there – we might expect that Asian cities will take less time to do the same.

Chapter 3 contributes to the scientific debate on the importance of parking (and car use) for retail areas. It contradicts the general dogma “no parking, no business”. I am aware that the analysis is based on Dutch shopping areas only, that the dataset is limited in the number of observations, and that the fact that we did not find a relationship does not mean that there is no relationship. However, there is a growing evidence in other European countries – among others CBRE (2014), National Transport Authority (2014) and ESRC (2014) – that supports the idea that parking might be less important for retail turnover than what is generally believed to be. Yet, contrary to the scientific contribution of the findings of chapter 2, I don't think we can generalize these results for non-European countries. For example, in car-oriented countries such as the USA and Australia the provision of parking might be positively related to retail turnover.

Chapter 4 makes use of similar methodology used in other P&R studies (Parkhurst 1995 and 2000) and it adds to existing literature the case of rail-based P&R. The novelty of this chapter is twofold. First it identifies two new unintended effects of P&R facilities, namely ‘abstraction from bike’ and ‘Park and walk users’. Second, the findings suggest that remote P&Rs perform better than peripheral P&Rs in terms of net impact of traffic reduction. This outcome further fuels the scientific debate on the effectiveness of P&R policies as policy instrument to reduce car traffic in and around cities.

Chapter 5 increases the, at the moment, thin literature on resident parking. It focuses on a niche of it, namely the residential visitor parking permit, and only on the case of The Hague. Accordingly, any kind of generalization cannot be done. However, the outcome of the study provides some knowledge on a topic that, while it has received little or no attention in the

literature, it concerns a policy instrument that is used in many cities, not only in the Netherlands.

### 6.3 Policy implications and recommendations

This study identifies several implications and recommendations for parking policy. The most important ones are discussed below.

#### 1) The need for a strategic approach

Chapter two shows that a major shift in urban parking policy occurs when a city enters phase three. In phase one and two urban planners and policy makers simply follow the consecutive steps – i.e. time restriction, pricing parking, and extension of the pricing area - in a rather reactive way, often failing to see parking in a more holistic planning context. When a specific parking problem occurs, for example spillover effects at the edge of the paid parking area, the corresponding solution is implemented – extension of the pricing area. This approach might work for phases one and two but by the time a city moves to the third phase the complexity of parking policy is such that a more strategic approach is required.

This strategic approach requires the full integration of parking policy within the general urban and transport policy of the city and the incorporation of parking in a broader demand management strategy. For achieving this, some major shifts must occur in policy making:

- First, the supply of parking – i.e. the number of parking places by type and location – must be adequately inventoried.
- Second, planners and policy makers must re-think parking requirements in the light of the inadequacy of national guidelines. Parking requirements should be more flexible, considering the specific characteristics of each site and activity, and should find the right trade-off between the needs of the public authority and the needs of private developers. Ultimately, the new strategic approach to parking would lead to parking standards defined per area and not, as it is currently the case, per building; be expressed as a range and linked to accessibility by other modes. Policy makers and planners should also consider the total parking supply in the area before requiring new capacity, and seek ways to allow multiple uses of parking facilities.
- National government should play an active role in encouraging cities to take a more innovative approach to parking policy and in highlighting to them the need to place parking policy within a wider strategic transport-planning context. For example, the national government could use spatial planning legislation to create more room for local authorities' initiatives and could downgrade the importance of parking requirement guidelines.
- Marketing and communication must play a fundamental role within parking policy. Often the only communication about parking provided by the local authority is about how the system works – i.e. time restrictions, ticketing machines, permits, etc. – but hardly about why the system is in place – that is, why the user should pay for parking, how parking income is utilized, and so on. The San Francisco parking scheme mentioned in chapter two is a good example of this: in the words of the authors "... SFpark helps to depoliticize parking by stating a clear principle for setting the prices for curb spaces" (Pierce and Shoup, 2013: p. 69).
- Finally, decision-making should be based on knowledge and facts. Information must be carefully collected and analyzed before taking (expensive) investment decisions. Data collection and analysis are used in many sectors within transport like railway

companies, airlines and car manufactures. Parking has simply become too important and too expensive for public authorities and decision making to be based on anything other than sound knowledge.

Considering the future of urban parking one can identify three major challenges that policy makers will face in phase three, namely:

- a) Increasing pressure on the financial aspects of parking policy. The trend towards a larger use of expensive (often underground) off-street facilities, the growing political pressure on parking charges (mainly retailers asking for lower charges) and the increased costs associated with the enlargement and enforcement of the paid parking area on-street can easily lead to a situation where the costs of implementing parking policy rise faster than revenues.
- b) The need to decouple new developments from existing parking requirements. Rigid parking standards are not appropriate for managing parking in phase three. National guidelines (on parking standards) are simply not able to reflect adequately the site-specific characteristics of new development. For example, a growing number of private companies are using TDM policies to reduce car dependency among employees and local authorities must consider this when deciding how much parking the company has to provide.
- c) The introduction of parking regulations in residential and suburban locations. While the use of active parking regulation – especially pricing – is (more or less) accepted in the central areas of at least medium and larger cities, more controversial will be its acceptance in peripheral residential areas, not to mention in suburban municipalities.

## 2) The (un)importance of parking for retail

The analysis in chapter three suggests that, at least for the Netherlands, the dogma ‘no parking, no business’ is mostly incorrect. Accordingly, four major implications for policy can be identified:

- a) First, the findings might help planners in the debate about parking with the retail sector. Very often this debate is based on feelings and emotions rather than on facts. Chapter three provides some evidence that parking might be less important for shopping area turnover than is generally believed.
- b) Second, the results might support local authorities willing to implement restrictive parking policy, both in terms of reduced capacity and/or in terms of increased tariffs. With the specific exception of the regional shopping centers, the findings show that both measures, on their own, are not harmful for the turnover of shopping areas.
- c) Third, the outcomes might also help local authorities and project developers to build less parking capacity in new (re)developments. Reducing parking capacity will considerably reduce construction costs.
- d) Fourth, the simple monetary calculation performed in chapter three (see 3.4.2) suggests that, even when there is a significant positive relationship between parking capacity and turnover, the investment in parking might not be feasible from a financial point of view for all shopping areas.

## 3) A comprehensive approach to P&R policy

Chapter four presents three main implications for P&R policy:

- a) First, the use of P&R facilities should be regularly monitored. This seems to be necessary to understand whether they fulfill their original policy goals. Most, if not all, of the unintended effects are unavoidable, but their monitoring is essential to try,

- where possible, to reduce their magnitude by designing and implementing dedicated policies.
- b) Second, paid parking should be taken into consideration when designing P&R policies. While it is not meant to fully recover the costs of the facility, it might be an important tool to regulate the unintended effects, especially the improper use. The fee should be competitive with respect to the parking fee on the final destination, otherwise motorists might prefer to continue their car trip until they arrive downtown.
  - c) Third, if the final aim of the policy is to reduce overall car use, remote P&R locations should be preferred to peripheral ones. Not only would the magnitude of the unintended effects be lower, but by intercepting the motorists at an early stage, the car part of the chain trip is reduced in favor of the public transport part.

All in all, a comprehensive approach to P&R is needed in order for policy to achieve the primary goal of overall reduction in car use. This might go beyond the sphere of influence of local authorities and require a more regional policy approach that includes also the major public transport operators like railways and interurban coach services.

#### 4) Residential visitor parking

The analysis of the residential visitor parking permit in The Hague suggests three major policy recommendations:

- a) The first is that the use of data analysis can help policy makers in the debate with citizens, especially on such an emotional topic as parking. Rather than relying on feelings and emotions, data can provide policy makers with objective information to support the discussion. In this specific case, the analysis of data suggests that there is no need to change drastically the policy because of the citizens' inquiry. Minor changes to the policy might be enough. This is a very important implication and holds true not only for the issue of resident permits but also for many other aspects related to parking. Also the analysis in chapter three (retail) and four (Park and Ride) support the importance of data analysis in parking policy.
- b) Next, the gap between perception of the problem by residents and reality might be bridged by means of better communication by the local authority. For example, a clear and adequate communication regarding the functioning of the system and the objectives of the policy might contribute to increase citizens' acceptance of paying for parking.
- c) Finally, local authorities should consider the possibility to customize their parking products on the base of the users' needs. In the specific case analyzed in chapter five this means not offering a "one-size-fits-all" permit – i.e. all residents in the same district get the same amount of hours per year for the same price – but different kind of permits (e.g. small, medium, large) at different fees.

While chapter five focuses on a very specific aspect of parking policy and analyses a single case study, the policy implications - more use of data analysis, better communication and more flexible policies – hold for almost all issues related to parking policy.



## 6.4 Suggestions for further research

This research has produced various new insights for policy making and research on parking. Of course, each chapter of this thesis presents some limitations. Based on these limitations, on my reading of the scientific literature on parking and on the general knowledge I gained as researcher and policy advisor, I have three main suggestions for further research.

First, I think there is still a large gap between academics and parking professionals (urban planners, policy makers, advisors...). Even though in the last decades more academics have studied parking related topics and more professionals have come across some academic studies on parking, the distance between these two groups is still considerable and the interaction among them still poor. There is a mismatch between the knowledge needed by professionals and the knowledge produced by academics, often because academics are driven by different goals than policy makers. For example, while the study of price elasticity of demand for parking might not be very exciting from an academic point of view, it is of fundamental importance for decision makers. Future academic research on parking should aim to bridge this gap in order to help policy makers to produce more evidence based parking policy.

Second, more quantitative research on parking is necessary. New options for such research emerge because nowadays virtually every parking transaction made through a pay and display machine, a mobile phone or through a (garage) barrier is registered. However, still few researches make use of these data. Much under-utilized data on parking transactions are stored in the cloud or on hard disks somewhere by local authorities and parking operators. The analysis of these data can provide very useful information about car parking behavior and the effects of different policy measures.

Finally, more academic research should focus on the role of different transport modes on the performance of retail areas. In recent years, urban retail has gone through a very difficult period, which has led to severe consequences for some firms and town centers. While there are many factors that might explain this – among others the economic recession of the last years, the advent of e-shopping that has dramatically changed consumer behavior and the thoughtless real estate policy of some cities – parking has become the favorite target for complain among local retailers. Accordingly, policy makers around Europe are under pressure not to introduce policies that aim to reduce car use. It is imperative that the scientific community helps policy makers to better understand the role the car should have in the 21st century cities. Especially, there is more need for quantitative studies because the evidence existing at present is still scarce (ESRC, 2014). While more data on parking and modal split of the visitors will be available, the real challenge will be to gather reliable information about retail turnover, in view of the fact that retailers usually are not willing to share this information.

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## Epilogue

This thesis deals with the policy aspect of parking and, accordingly, with mainly one specific actor in the parking sector, namely the local government. It makes explicit that parking is a very complex issue and that policy makers need to be better informed to deal with it effectively. Hopefully, this thesis will give them part of this knowledge. However, there is another actor in the parking sector that is in need of having and applying new knowledge on parking, and that is the parking industry, namely parking operators, suppliers of Parking Management Systems (PMS) and real estate investors.

For many years the business for these parties was relatively easy. They operated in an environment where car ownership and use were steadily growing, people and governments were used to accepting growing congestion levels as a consequence of growing economic welfare, alternatives to car use were often poor or not fashionable, and competition (from outside the sector) was almost not existing. Additionally, they also had the luxury not have to worry too much about consumer needs, because demand for parking kept growing.

In the last ten years all of the abovementioned has dramatically changed. Car ownership, car use and the demand for parking is not growing at the same pace as before, and in some cities it is not growing at all or it is declining. People (and governments) want to live, work and pass their leisure time in less congested urban areas. Alternatives to the car have improved and gained market shares in many cities; some of them, like biking, are becoming quite fashionable among specific groups of people. Lastly, Information-Communication Technology developments have completely changed the needs and the behavior of consumers, and have enlarged the competitive arena for the parking industry.

Like decision makers need a paradigm shift in policy making, so does the parking industry need a cultural shift in its modus operandi. The parking operator A that still thinks that its main competitor is parking operator B, has not a bright future ahead. A real estate developer that fights the decision of a city council trying to reduce the number of cars in the city center, because he is afraid his parking garage or shopping center will have fewer customers, will most probably keep investing in the wrong way. A PMS supplier that still thinks he will make money in the future selling ticket machines and barriers will run out of business. Anyone in the sector who still believes that the three main success factors for a parking garage are 'location, location and location' should start looking for another job. 'Data, information, knowledge and wisdom' are probably the most important raw materials of the 21<sup>st</sup> Century; not only for Google or Apple, but also for the parking industry. So, dear friends in the parking sector, wake up! The 21<sup>st</sup> Century started 16 years ago.



# Summary

## Background and goal of the research

Since the sixties the car has been the dominant mode of transport for passengers in most (if not all) OECD countries. However, despite being built to move people, a car spends on average more than 95% of its existence parked (Shoup, 2005; Bates, 2014). This should be enough to seriously consider parking and parking policy as topics of both academic and societal interest. But there are four other arguments that make parking an interesting object for scientific research. First, parking plays an important role in the decision on whether to possess and/or use a car. Second, parking takes (a lot of) space and space is particularly scarce in urban areas. Third, parking is a very costly infrastructure to provide. Fourth, parking related income can be a major source of own income for many local authorities.

Parking policy is a very complex issue for three main reasons. First, there are plenty of misunderstandings and dilemmas within parking policy. Some of these policy dilemmas might even include possible conflicts of interest for the policy maker like the trade-off between municipal income and traffic congestion. Second, despite having multiple effects i.e. transport, environment, land use, economic and social development and finance, parking usually falls under the transport department of the city. This means that usually the approach to parking is purely a traffic and transportation approach, often led by people with a technical background. Third, there is relatively little knowledge available, both in the scientific and grey literature. The complexity of parking policy means that, usually, local policy makers must tackle a difficult theme.

Although the literature on parking has grown enormously in the last 5–10 years, for policy makers there are still many questions that have not been answered. This might partially be caused by the gaps between academic research and policymaking. For academics not all policy issues are interesting topics for research and, on the other hand, for policy makers much academic research might be not interesting or simply not accessible and/or too difficult to understand. Two main knowledge gaps, which are relevant for policy making can be identified in the academic literature on parking:

1. A general theory explaining the development of parking policy is still missing, especially within a European context.

2. The effects of many specific parking policies are not yet known. This type of knowledge is also very important for policy makers in order to implement the right policy options.

This thesis aims to reduce the abovementioned knowledge gaps in two ways:

- a) By providing a general framework for the development of parking policy in European urban areas (chapter 2).
- b) By contributing to the scientific knowledge on the relationship between parking and retail (chapter 3), on the effects of rail-based Park and Ride (P&R) facilities (chapter 4) and on the use of a residential visitors parking permit system (chapter 5).

These four aspects of parking policy are just some of the issues that are relevant for research on parking. Other important issues that are not considered in this thesis are for example: parking standards, parking and mobility management, parking management schemes in companies, enforcement, legislation, marketing and communication, new technology applied to parking.

## Theory and methodology

This thesis is based on four papers (chapters 2 to 5). The first paper – *Urban parking policy* (chapter 2) – intends to contribute to theory in the field of urban planning. It is probably one of the first attempts to form a comprehensive theoretical framework for urban parking policy, surely at European level. The methodology used in the paper is inspired by grounded theory. This method is used to generate theories from both inductive and deductive thinking (Glaser, 1992). First, we generated concepts regarding parking policy based on the scientific and grey literature and on the authors own working experience. Second, we discussed these concepts with several experts and academics in the field and modified it if needed.

The remaining three papers do not intend to directly contribute to theory formation, but are embedded in the theory of urban and transport economics and planning. They contribute to existing literature mainly by adding empirical evidence as follows:

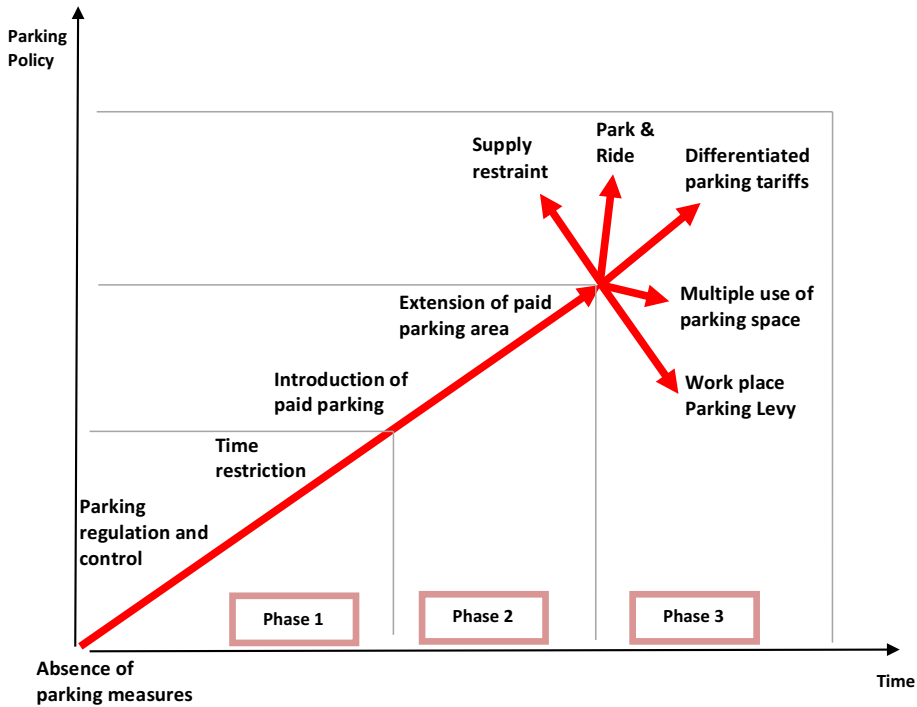
The second paper – *Is parking supply related to turnover of shopping areas?* (chapter 3) – contributes to the debate on the importance of parking for the retail sector. This paper uses a quantitative approach. It makes use of a multiple regression model to investigate the effect of parking on the turnover of 83 shopping areas in the Netherlands.

The third paper – *Transport and environmental effects of train-based Park and Ride (P&R)* (chapter 4) – differs from the mainstream literature as it considers train-based P&R facilities rather than bus-based P&R. Additionally, it adds a number of new ‘unintended effects’ that were not previously observed in literature. It makes use of two questionnaire-based users’ surveys and specific field observations at nine rail-based (train, metro and conventional train) P&Rs located in the metropolitan areas of Rotterdam and The Hague in the Netherlands.

The fourth paper – *Residential visitors parking permit* (chapter 5) – adds to the thin existing literature on residential parking by discussing an entirely new topic, namely the case of visitor parking permits for residents i.e. the possibility for residents living in areas with paid parking to buy a number of parking hours that can be used for their visitors. This paper applies an exploratory case study approach in which the authors combine both quantitative and qualitative methods.

## Results

Chapter two argues that most European cities follow more or less the same pattern when it comes to parking policy (Figure S.1). Within this pattern, one can distinguish three main phases: the rise of parking regulation (Phase 1), the advent of pricing parking (Phase 2) and the integration of parking policy in overall Transportation Demand Management strategies (Phase 3). Nowadays, most cities and towns in Europe have entered (or are entering) the third phase. In most of them there is tension between the reactive/operational approach to managing parking, typical of phase one and two and the more strategic, evidence based approach necessary for phase three.



**Figure S.1: The staged development of urban parking policy**

Chapter three discusses a hot societal issue, namely the importance of parking for the retail sector. Generally speaking, shop owners, retail managers and branch organisations strongly believe that parking plays a fundamental role in the performance of shopping areas. Accordingly, local authorities are often under pressure to provide additional parking capacity and/or reduce or freeze parking tariffs in and around shopping areas, even in busy downtown locations. The outcome of the research indicates that:

- there is a positive significant relationship between parking tariffs and turnover per square metre of sales floor surface (SFS m<sup>2</sup>);
- the supply of parking has no influence on turnover of shopping areas;
- for the category ‘regional shopping areas’ i.e. between 100 and 400 shops, there is a significant positive relationship between parking capacity and turnover.

Chapter four builds on the existing literature on P&R and adds empirical evidence that may contribute to a better understanding of the impact the different types of P&R may have on travel behaviour and car use. The analysis suggests three main findings:

- two new unintended effects have been identified, more specifically ‘abstraction from bike’ (partial or total) and ‘park and walk users’;
- the introduction of a price for using the P&R facilities should contribute to reducing the magnitude of the unintended effects;
- there exists an important difference in the net impact of P&Rs in terms of vehicle km travelled (VKT) and vehicle emissions between remote (with an origin function) and peripheral (with a destination function) facilities. The use of peripheral P&R leads to a negative net effect in terms of additional VKT and vehicle emissions.

Chapter five makes use of both quantitative and qualitative research to explore a new topic in the parking literature, namely residential visitor parking permits in the city of The Hague (the Netherlands). The most important findings are:

- a relatively large number of residents never used the permit despite buying it. In some districts of the city, this is more than 20% of permit holders. Considering the fact that the price of the permit (€18) covers just a fraction of the costs incurred by the local authority, the practice of requesting a permit and not using it might be quite costly for the local authority;
- on average the percentage of residents that might have a problem in terms of not having enough hours i.e. those using 100% of the available hours, is relatively low (3.27%). This suggests that there probably is no need to increase the number of hours, but it might be wise to add some degree of flexibility in the system;
- the survey and the focus groups suggest that the quality of the system and its user-friendliness might be improved through better communication and, most probably, with the use of a mobile app.

## Implications for policy

This study identifies several implications and recommendations for parking policy, the most important being:

1. The need for a strategic approach to parking policy. This requires the full integration of parking policy within the general urban and transport policy of the city and the incorporation of parking in a broader demand management strategy. To achieve this, some major shifts must occur in policy making such as:
  - an adequate inventory of parking supply must occur;
  - planners and policy makers must re-think parking requirements in the light of the inadequacy of national guidelines;
  - marketing and communication must play a fundamental role within parking policy;
  - decision-making should be based on knowledge and facts rather than on feelings and emotions.
2. The (un)importance of parking for retail. This suggests that the dogma ‘no parking, no business’ is mostly incorrect and that local authorities willing to implement restrictive parking measures can do so knowing that they are not detrimental to the local economy.



3. P&R policy needs a comprehensive approach. This calls for regular monitoring of their use and the possibility to introduce paid parking in the P&R locations. Additionally, if the final aim of the policy is to reduce overall car use, remote P&R locations should be preferred to peripheral ones.
4. Some aspects of parking policy i.e. residential visitor parking, might benefit greatly from better communication between the local authority and the recipients of the policy and from the possibility of customising the products.

## Suggestions for further research

This PhD research has produced some relevant insights for parking policy. Of course, each chapter of this thesis presents some limitations. Based on these limitations, on my reading of the scientific literature on parking and on the general knowledge I gained as a researcher and policy adviser, I have three main suggestions for further research:

- First, I think there is still a large gap between academics and parking professionals (urban planners, policy makers, advisers...). Even though in the last decades more academics have studied parking related topics and more professionals have come across some academic studies on parking, the distance between these two groups is still considerable and the interaction among them still poor. There is a mismatch between the knowledge needed by professionals and the knowledge produced by academics, often because academics are driven by different goals than policy makers. Future academic research on parking should aim to bridge this gap in order to help policy makers produce more evidence based parking policy.
- Second, more quantitative research on parking is necessary. New possibilities for such research emerge as nowadays virtually every parking transaction made through a pay and display machine, a mobile phone or through a (garage) barrier is registered. The analysis of these data can provide very useful information about car parking behaviour and the effects of different policy measures.
- Finally, more academic research should focus on the role of different transport modes in the performance of retail areas. In recent years, urban retail has gone through a very difficult period, which has led to severe consequences for some firms and town centres. While there are many factors that might explain this, parking has become the favourite target of complaint among local retailers. Accordingly, policy makers around Europe are under pressure not to introduce policies that aim to reduce car use. It is imperative that the scientific community helps policy makers to better understand the role the car should have in twenty-first century cities.

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# Samenvatting

## Achtergrond en doel van het onderzoek

De auto is sinds de jaren zestig de dominante wijze van vervoer voor passagiers in de meeste (zo niet alle) OESO-landen. Echter, ondanks dat de auto gemaakt en gekocht wordt voor het verplaatsen van mensen, besteedt een auto gemiddeld meer dan 95% van haar bestaan geparkeerd (Shoup, 2005; Bates, 2014). Dit feit alleen zou al genoeg moeten zijn om parkeren en parkeerbeleid serieus te nemen als onderwerpen van zowel academisch als maatschappelijk belang. Maar daarnaast zijn er nog vier argumenten waardoor parkeren een interessant onderwerp voor wetenschappelijk onderzoek is. Ten eerste speelt parkeren een belangrijke rol bij beslissingen met betrekking tot het bezit en/of het gebruik van de auto. In de tweede plaats neemt parkeren (veel) ruimte in en ruimte is schaars in stedelijke gebieden. Ten derde vraagt parkeren een zeer kostbare infrastructuur. En ten vierde zijn parkeer-gerelateerde inkomsten een belangrijke bron van inkomsten voor veel lokale overheden.

Parkeerbeleid is een hele complexe aangelegenheid. Daar zijn drie belangrijke redenen voor aan te voeren. Ten eerste bestaan er veel misverstanden en dilemma's rondom parkeerbeleid. Sommige van deze beleidsdilemma's bevatten belangenconflicten voor beleidsmakers, zoals de trade-off tussen de gemeentelijke inkomsten en de verkeersdruk in de stad. Ten tweede valt parkeren meestal onder de afdeling verkeer en vervoer van de lokale overheid, terwijl parkeren op veel meer terreinen invloed heeft. Denk aan milieu, ruimtelijke ordening, economische en sociale ontwikkeling en financiën. Dit betekent dat de aanpak van parkeren vaak enkel gericht is op verkeer en vervoer, uitgevoerd door mensen met een technische achtergrond. Ten derde is er relatief weinig kennis beschikbaar, zowel in de wetenschappelijke als in de overige literatuur. De complexiteit van parkeerbeleid betekent dat lokale beleidsmakers een moeilijk thema aan moeten pakken.

Hoewel de hoeveelheid literatuur over parkeren in de laatste 5-10 jaar enorm gegroeid is, zijn er voor beleidsmakers nog veel vragen niet beantwoord. Dit kan gedeeltelijk worden veroorzaakt door de verschillen tussen academisch onderzoek en beleidsvorming. Voor academici zijn niet alle beleidskwesties interessante onderwerpen voor onderzoek en aan de andere kant is veel academisch onderzoek voor beleidsmakers niet interessant of gewoon niet toegankelijk en/of te moeilijk te begrijpen. Een ander belangrijk punt is dat er twee duidelijke

kennishiaten geïdentificeerd kunnen worden in de academische literatuur over parkeren die van invloed zijn op beleidsvorming:

1. Er is geen algemene theorie die de ontwikkeling van het parkeerbeleid verklaart. Vooral in een Europese context.
2. De effecten van veel specifieke maatregelen binnen het parkeerbeleid zijn nog niet bekend. Deze kennis is zeer belangrijk voor beleidsmakers om de juiste beleidsinstrumenten in te kunnen zetten.

In dit proefschrift worden bovengenoemde lacunes in kennis op twee manieren ingevuld:

- a) door het beschrijven van een algemeen kader voor de ontwikkeling van het parkeerbeleid in Europese stedelijke gebieden (hoofdstuk 2).
- b) door een wetenschappelijke bijdrage te leveren aan drie parkeer-thema's: de relatie tussen parkeren en retail (hoofdstuk 3), de effecten van rail-based P&R voorzieningen (hoofdstuk 4) en het gebruik van een bezoekers parkeervergunningstelsel voor bewoners van de stad (hoofdstuk 5).

Deze vier aspecten van het parkeerbeleid zijn slechts een aantal kwesties die relevant zijn voor onderzoek naar parkeren. Andere belangrijke onderwerpen die niet aan bod komen in dit proefschrift zijn bijvoorbeeld: parkeernormen, parkeren en mobiliteitsmanagement, parkeermanagement bij bedrijven, handhaving, wetgeving, marketing en communicatie en nieuwe technologieën die gebruikt kunnen worden bij parkeren.

## Theorie en methodologie

Dit proefschrift is gebaseerd op vier artikelen (hoofdstukken 2 tot en met 5). Het eerste artikel – *Urban Parking Policy* (hoofdstuk 2) – levert een bijdrage aan de theorie op het gebied van ruimtelijke ordening en parkeren. Het is waarschijnlijk een van de eerste pogingen om een uitgebreid theoretisch kader voor stedelijk parkeerbeleid te maken, zeker op Europees niveau. De methodologie die in het artikel gebruikt is, is gebaseerd op de grounded theory. Deze methode genereert theorieën van zowel het inductieve als het deductieve denken (Glaser, 1992). Eerst hebben we concepten met betrekking tot parkeerbeleid opgesteld op basis van wetenschappelijke en grijze literatuur en op basis van de eigen werkervaring van de auteurs. Vervolgens hebben we deze concepten met verschillende deskundigen en academici besproken en bewerkt indien nodig.

De resterende drie artikelen leveren geen directe bijdrage aan de vorming van de theorie maar zijn een onderdeel van de theorie van de stedelijke- en transporteconomie en planning. Ze leveren een bijdrage aan de bestaande literatuur voornamelijk door het toevoegen van empirisch bewijs.

Het tweede artikel – *Is parking supply related to turnover of shopping areas?* (hoofdstuk 3) – draagt bij aan het debat over het belang van parkeren voor de detailhandel. Dit artikel heeft een kwantitatieve benadering. Het maakt gebruik van een meervoudige regressieanalyse om het effect van parkeren op de omzet van 83 winkelgebieden in Nederland te onderzoeken.

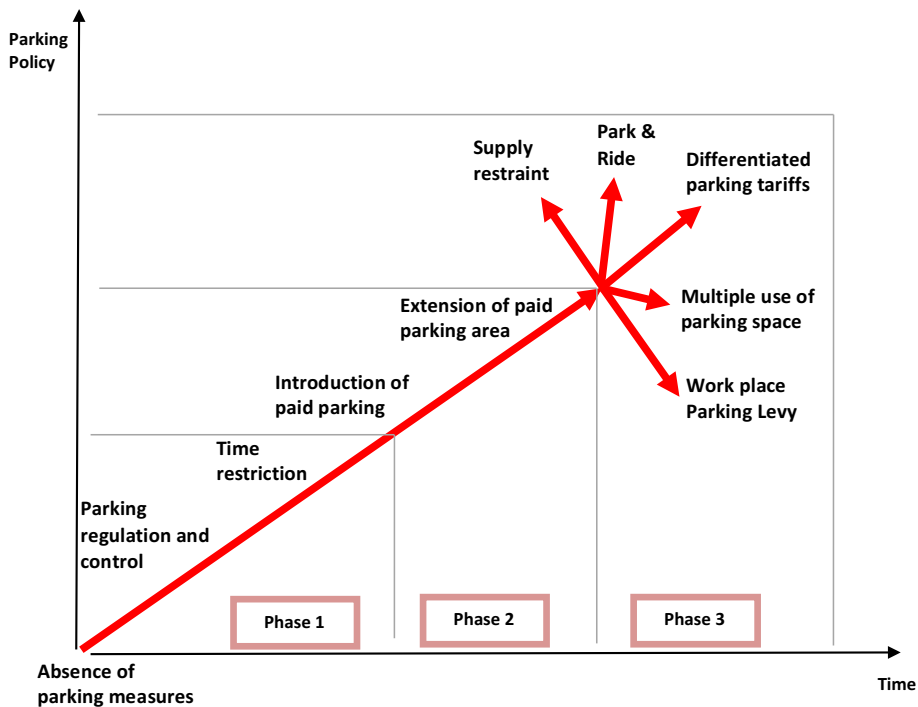
Het derde artikel – *Transport and environmental effects of rail-based Park and Ride* (hoofdstuk 4) – onderscheidt zich van de mainstream literatuur, omdat de focus ligt op train-based P&R-faciliteiten in plaats van op de bus-based P&R. Bovendien voegt het een aantal nieuwe "onbedoelde effecten" toe aan de literatuur die voorheen niet werden beschreven. Het artikel is gebaseerd op de uitkomsten van twee gebruikers enquêtes en veld observaties in

negen train-based [trein-, metro- en light-rail] P&R's gelegen in de stedelijke gebieden van Rotterdam en Den Haag.

Het vierde artikel – *Residential visitors parking permit* (hoofdstuk 5) – voegt een heel nieuw onderwerp toe aan de geringe hoeveelheid bestaande literatuur over bewoners parkeren. Het beschrijft namelijk het gebruik van parkeervergunningen voor bezoekers van de bewoners van de stad. Het gaat hierbij om de mogelijkheid voor bewoners – die in een betaald parkeren zone wonen - om een aantal ‘parkeeruren’ te kopen die kunnen worden gebruikt voor hun bezoekers. Dit artikel behelst een verkennende studie waarin de auteurs zowel een kwantitatieve als een kwalitatieve methode combineren.

### Resultaten

Hoofdstuk twee betoogt dat de meeste Europese steden min of meer hetzelfde patroon volgen als het gaat om het parkeerbeleid (figuur S.1). Binnen dit patroon kan men drie belangrijkste fasen onderscheiden: de opkomst van de parkeerregulering (fase 1), de komst van betaald parkeren (fase 2) en de integratie van het parkeerbeleid in algemene Transport Demand Management strategieën (fase 3). Tegenwoordig zitten (of naderen) de meeste steden in Europa in de derde fase. In de meeste gevallen is er een spanning tussen de reactieve/operationele aanpak van het beheer van parkeren, typisch van fase één en twee, en de meer strategische benadering die noodzakelijk is voor fase drie.



Figuur S.1: De ontwikkeling van stedelijk parkeerbeleid

Hoofdstuk drie bespreekt een actuele maatschappelijke kwestie, namelijk het belang van parkeren voor de detailhandel. Over het algemeen zijn winkeliers, retail-managers en brancheorganisaties ervan overtuigd dat parkeren een fundamentele rol in de prestaties van winkelgebieden speelt. Als gevolg hiervan staan lokale overheden vaak onder druk om te zorgen voor extra parkeercapaciteit en/of het verminderen of bevriezen van de parkeertarieven in/nabij winkelstraten, zelfs op drukke binnenstedelijke locaties. De uitkomst van het onderzoek geeft aan dat:

- er een significante positieve relatie is tussen parkeertarieven en omzet per vierkante meter verkoop-vloeroppervlak (SFS m<sup>2</sup>);
- parkeercapaciteit geen invloed heeft op de omzet van winkelgebieden;
- voor de categorie 'regionale winkelgebieden' – tussen 100 en 400 winkels – er een significante positieve relatie is tussen parkeercapaciteit en omzet.

Hoofdstuk vier bouwt voort op de bestaande literatuur over P&R en voegt empirisch bewijs toe dat kan bijdragen aan een beter begrip van de effecten die de verschillende soorten P&R kunnen hebben op het auto gebruik. Uit de analyse komen drie belangrijke bevindingen naar voren:

- twee nieuwe onbedoelde effecten zijn geïdentificeerd, namelijk "onttrekking aan de fiets" [gedeeltelijke of helemaal] en "Park en Walk gebruikers";
- de invoering van een prijs voor het gebruik van de P&R faciliteiten leidt tot een vermindering van de omvang van de onbedoelde effecten;
- er bestaat een belangrijk verschil in het netto-effect in termen van VKT (vehicle kilometers travelled) en uitstoot tussen 'herkomst P&R' en 'bestemming P&R'. Het gebruik van de 'bestemming P&R' leidt tot een negatief netto-effect in termen van extra VKT en voertuigemissies.

Hoofdstuk vijf maakt gebruik van zowel kwantitatief als kwalitatief onderzoek om een nieuw onderwerp in de literatuur over parkeren ter verkennen. Namelijk de bezoekers parkeervergunning, waarbij Den Haag als casestudie is gebruikt. De belangrijkste bevindingen uit dit onderzoek zijn:

- een relatief groot aantal bewoners gebruikt de vergunning nooit, ondanks het feit dat ze hem wel gekocht hebben. In sommige wijken van de stad geldt dit voor meer dan 20% van de vergunninghouders. Gezien het feit dat de prijs van de vergunning (€18) slechts een fractie van de kosten dekt die door de lokale overheid worden gemaakt om deze vergunningen uit te geven, is zo'n vergunning een onnodig hoge kostenpost voor de gemeente;
- het gemiddelde percentage vergunninghouders die wellicht een probleem heeft - die alle beschikbare uren gebruiken binnen een jaar – is relatief laag (3.27%). Dit suggereert dat er waarschijnlijk geen noodzaak is om het aantal uren te verhogen, maar zou een zekere mate van flexibiliteit in het systeem wenselijk zijn;
- uit de enquête en de gesprekken met de focusgroepen blijkt dat de kwaliteit van het systeem en de gebruiksvriendelijkheid verbeterd kan worden door betere communicatie. Bijvoorbeeld door het gebruik van een mobiele app.

## Beleidsaanbevelingen

Dit proefschrift bevat een aantal aanbevelingen voor beleidsmakers, de belangrijkste zijn:

1. er is een noodzaak voor een strategische aanpak van parkeerbeleid. Dit vereist de volledige integratie van het beleid binnen het algemene stedelijke en vervoersbeleid van de stad. Bovendien moet parkeren opgenomen worden in een bredere demand management strategie. Om dit te bereiken zijn enkele grote verschuivingen in de beleidsvorming nodig:
  - er moet een adequate inventarisatie van parkeren plaatsvinden;
  - planners en beleidsmakers moeten de parkeereisen heroverwegen gezien de ontoereikendheid van de nationale richtlijnen;
  - marketing- en communicatie moeten een fundamentele rol spelen binnen het parkeerbeleid;
  - besluitvorming moet gebaseerd zijn op kennis en feiten en niet op gevoelens en emoties.
2. de (on)belangrijkheid van parkeren voor de detailhandel. Dit suggereert dat het dogma "no parking, no business" meestal niet juist is en dat lokale overheden die het autogebruik in de binnenstad willen beperken door middel van parkeermaatregelen dit kunnen doen zonder dat dit schadelijke gevolgen heeft voor de lokale economie.
3. P&R-beleid heeft behoefte aan een allesomvattende aanpak. Dit vraagt om regelmatige monitoring van het gebruik van parkeren en de mogelijkheid om betaald parkeren op de P&R-locaties in te voeren. Als bovendien het uiteindelijke doel van het beleid de vermindering van het algemene autogebruik is, dan hebben herkomst P&R-locaties de voorkeur boven bestemming P&R-locaties.
4. Sommige aspecten van het parkeerbeleid, b.v. bezoekers parkeervergunning, kunnen sterk profiteren van betere communicatie en van de mogelijkheid om het product op maat aan te bieden.

## Vervolgonderzoek

Dit PhD onderzoek bevat enkele relevante inzichten voor het parkeerbeleid. Uiteraard heeft elk hoofdstuk wel enkele beperkingen. Op basis van deze beperkingen, mijn studie van de wetenschappelijke literatuur over parkeren en de kennis die ik als onderzoeker en beleidsmedewerker heb opgedaan, heb ik drie belangrijkste suggesties voor vervolgonderzoek:

- Ten eerste denk ik dat er nog steeds een groot gat bestaat tussen academici en parkeer professionals (beleidsmakers, stedenbouwkundigen, adviseurs...). Hoewel in de laatste decennia meer academici het onderwerp van parkeren hebben bestudeerd en meer professionals een academische publicatie over parkeren hebben gelezen, is de afstand tussen deze twee groepen nog steeds aanzienlijk en de interactie tussen hen nog steeds nauwelijks aanwezig. Er is een discrepantie tussen de kennis die nodig is voor de professionals en de kennis die door academici wordt gepubliceerd, vaak omdat academici andere doelen hebben dan beleidsmakers. Toekomstig academisch onderzoek over parkeren moet dit gat dichten om beleidsmakers te helpen meer bewijs-gebaseerd parkeerbeleid te kunnen maken.
- Ten tweede is meer kwantitatief onderzoek over parkeren noodzakelijk. Nieuwe mogelijkheden voor dergelijk onderzoek ontstaan omdat tegenwoordig vrijwel iedere parkeer-transactie wordt geregistreerd. De analyse van deze gegevens kan zeer nuttig

informatie bieden over het gedrag van de automobilisten en de effecten van verschillende beleidsmaatregelen.

- Tot slot moet meer academisch onderzoek zich richten op de rol van de verschillende vervoerswijzen op de performance van winkelgebieden. In de afgelopen jaren is de detailhandel in stedelijke gebieden door een moeilijke periode gegaan. Dit heeft geleid tot ernstige gevolgen voor een aantal ondernemingen en voor de stedelijke winkelcentra. Hoewel er veel factoren zijn die deze gevolgen zouden kunnen verklaren, is parkeren de ‘kop van jut’ geworden voor lokale winkeliers. Naar aanleiding hiervan staan beleidsmakers in veel Europese steden onder druk om geen beleid te maken dat gericht is op vermindering van het autogebruik. Het is noodzakelijk dat de wetenschappelijke gemeenschap beleidsmakers helpt om de rol die de auto in de ‘21<sup>ste</sup> eeuw-steden’ heeft beter te begrijpen.

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## About the author

Giuliano Mingardo was born on 8<sup>th</sup> October 1974 in Padova, Italy. In 2000 he graduated in Economics at Ca'Foscari University of Venice and in 2001 obtained a Master Degree in Urban Management at Erasmus University Rotterdam. Since 2001 he works for the Department of Urban, Port and Transport Economics (RHV) of the Erasmus University Rotterdam.

Giuliano is specialized in parking policy and mobility management and regularly advises local governments and large companies on these issues. He is an acclaimed speaker both at national and international level and organizes master classes for professional audiences as well. Among others, he is a member of the Advisory Board of the Parking Commission of the Dutch CROW/KpVV and a member of the Scientific and Technical Committee of the European Parking Association (EPA). At Erasmus University Rotterdam he teaches transport economics both at Bachelor and Master level.



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