Car Drivers' Preferences Regarding Parking in Industrial Parks: A Stated Choice Approach

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ABSTRACT

This paper presents the results of a study on car drivers' preferences regarding parking facilities at industrial parks. An internet based questionnaire is set up to collect car drivers' importance scores regarding various parking choice related aspects. In addition, a stated choice experiment is set up to investigate car drivers' preferences in more detail. It appears that parking costs, ease to find a free parking space, distance between parking and final destination, and safety of the car driver are important aspects for car drivers when choosing a parking space. The average importance scores are related to the personal characteristics gender, age, and education. The stated choice experiment mainly confirms these findings.

Keywords: parking, industrial parks, stated choice

INTRODUCTION

An increased effort in restructuring industrial parks resulted in an augmented interest in the parking situation in such areas. In the past, most cars were parked at the private area of a company. Because of an increase in car use and a decrease in available private space increasingly more cars are parked in public spaces along roads or parking lots. This holds for both employees and visitors of companies located in an industrial park. In many cases, cars parked at public spaces cause problems for other types of traffic in the area such as through traffic and loading traffic (e.g., Tchang, 2008; Louw *et al*, 2009). The problems are related to accessibility, circulation, and safety (Figure 1). At the moment little is known about

the parking behavior of employees and visitors in industrial parks. The same holds for the requirements of cars drivers regarding parking facilities at industrial parks.
In the past most parking studies focus on residential areas, central business areas and shopping centers. Only a few studies dealt with parking at industrial parks. A major reason for the limited interest in parking at industrial parks is the large amount of parking spaces at the areas of individual companies. This situation is changing due to local regulations for the presence of parking spaces at private areas: local taxes (Hobma, 1995) and local permits for parking (Matthijssen and Vissers, 2008).

Figure 1 - Parked cars at an industrial park

The study described in this paper is a first attempt to get more insight into the requirements regarding parking facilities of employees and visitors of industrial parks. To achieve the goal of the study, an internet based questionnaire is developed containing questions concerning the importance of various parking characteristics. In addition, a stated choice experiment is set up to investigate in more detail the effect of different characteristics of parking facilities on the attractiveness of parking facilities. The study is carried out at three different industrial parks in the Netherlands. Despite the focus on Dutch industrial parks, several general lessons regarding car drivers' sensitivity towards parking characteristics can be learned.

The remainder of the paper is organized as follows. First, attention is paid to parking at industrial parks. Next, the adopted research approach is described. This section if followed by a brief description of the data collection. In section 5 three different models are described, an overall model and two models that include differences between groups of respondents. The paper ends with the conclusions.

INDUSTRIAL PARKS AND PARKING

In the past little attention was paid to the parking situation at industrial parks. Parking was organized at private company areas and the number of problems due to parking was limited. The restructuring of mainly old industrial parks resulted into more efficient use of space for

economic use and a decrease of available parking facilities. Because of the location of the industrial parks and the origin of the employees working at the parks, the car is still the most popular means of transport to get to the parks. This situation resulted into a variety of parking problems in Dutch industrial parks.

According to Tchang (2008) industrial parks face several parking problems such as a shortage of parking spaces, improper use of parking spaces by non-employees, long search time for free parking space, and reduced accessibility of individual companies. The city of Amsterdam started a study on the effects of parking measures at industrial parks on solving parking problems. The study showed that parking measures reduces unwanted parking by people not working at the industrial parking and stimulate parking at the company's area. Only a few companies and employees indicate that parking measures results in a move of the company of workplace.

Louw *et al* (2009) indicates that most important problems in the context of outdated industrial parks are related to the opening up of the parks, space usage, and environmental protection. In case of the opening up of a park the following aspects are mentioned: poor accessibility, poor road conditions, shortage of alternative transport opportunities, and shortage of parking facilities and loading platforms. The shortage of parking facilities results into unsafe traffic situations. Louw *et al* conclude that in the near future the main challenges are more efficient use of space, sustainable parks, and park management. Regulation of parking is an important issue in future developments. Some initiatives are parking on roofs of firms and combined parking spaces.

To optimize the use of scarce available parking spaces, at the Science Park Amsterdam the principle of collective parking is applied (Bos, 2008). Several surface parking garages are built for both residents and employees. A parking manager organizes the use of the parking facilities.

The studies described in this section show that there is an increase of initiatives aimed at organizing parking at industrial parks. The studies present different ways to handle the increasing parking problems but do not give insight into car drivers' reactions on suggested parking measures.

RESEARCH APPROACH

The study of car drivers' preferences is regarding parking at industrial parks was split up into two parts. In the first part, respondents were asked to evaluate various characteristics of parking facilities in general. Respondents had to evaluate eight different aspects that are related to parking on a 7-points scale ranging from not important (score 1) to very important (score 7). The question in the questionnaire was: *'What is important for you when you choose a parking to park your car?*'. The following aspects were implemented in the questionnaire: the safety of the car, free of parking charge, the distance between parking and final destination, the safety of car driver, the chance on a free parking space, the cleanliness of the parking facility, the ease of finding a free parking space, and the presence of wide parking spaces.

In addition to the separate evaluation of the aspects, a stated choice experiment was set up. The following five characteristics of parking facilities are investigated in more detail: the car drivers' contribution to parking costs, walking time between parking and company,

presence of guarding at the parking, the type of parking facility, and the chance on a free space at the parking. All characteristics were varied at three different levels (Table 1). The characteristics and the accompanying levels are combined in choice alternatives using a fractional factorial design. In addition, three choice alternatives were randomly combined in a choice task (Figure 2). This choice task was completed by adding a base alternative 'None of these'. Per choice task, respondents were invited to choose one of the presented choice alternatives. Each respondent evaluated 9 different choice tasks.

Table 1 - Characteristics of parking facilities

Characteristics	*Levels*
The car drivers' contribution to parking costs	Nothing, 1 euro per day, 2 euro per day
Walking time between parking and company	1 minute, 2 minutes, 3 minutes
Presence of guarding at the parking	No, cameras, extra lightning
The type of parking facility	Own parking lot, public parking lot, public parking garage
The chance on a free space at the parking.	50 percent, 75 percent, 100 percent

The stated choice experiment was implemented in an extensive internet based questionnaire. The questionnaire was supplemented with questions concerning the respondents' personal characteristics and travel behavior.

Figure 2 - Example of a choice task

THE DATA

Respondents were invited by company email or invitation cards that were placed behind the windshield wiper of parked cars. The invitations were distributed at three different industrial parks in cities in the south of The Netherlands. In total 90 respondents completed the stated choice experiment. Because of the low number of respondents, the results of the study should be treated with some caution.

Table 2 shows some personal and commuting related characteristics of the respondents. The numbers in the table show that the respondents are equally distributed across the distinguished levels for the characteristics age and education. The distributions for gender and physical limitations are distorted.

Table 2 - Personal and travel related characteristics of respondents

Characteristic	*Level*	*Frequency*	*Percentage*
Gender	Male	71	81.1
	Female	17	18.9
Age	Younger than 45 years	46	51.1
	45 years and older	44	48.9
Educational level	Medium	45	50.0
	High	45	50.0
Physical limitations	Yes	0	0
	No	90	100.0
Visit frequency	Less than 4 times per week	10	10.1
	4 times or more per week	80	89.9
Visit purpose	Work	79	87.8
	Other	11	12.2
Visit duration	Less than 8 hours	24	26.7
	8 hours or more	66	73.3
Heavy goods	Yes	21	23,3
	No	69	76,7
Travel company	Alone	82	91.1
	With someone else	8	8.9

The respondents were also asked to describe their parking behavior when visiting the industrial park where they received the invitation to participate in the study. The respondent is asked to indicate where he or she usually parks the car when visiting the industrial park (Table 3). It appears that almost two third of the car drivers park the car at the companies (private) parking. In addition, the respondent is asked to indicate if he or she had to adapt their first parking choice because all parking facilities are fully occupied. Approximately one fifth of the car drivers indicated that they had to park at the for them second best alternative.

Table 3 - Parking related information

Characteristic	*Level*	*Frequency*	*Percentage*
Parking location	Company parking	57	63.3
	Public parking	15	16.7
	Along the road	18	20.0
Adapt parking choice	Yes	20	22.2
	No	70	77.8

PARKING RELATED ASPECTS

The respondents evaluated eight different aspects that are related to their parking choice. Figure 3 presents the average importance scores of the investigated aspects. It appears that on average car drivers evaluate all aspects as important. The aspect 'free of parking charge' is the most important aspect when choosing a parking facility. This aspect is followed by the aspects 'chance on a free space', 'distance between parking and final destination', and 'safety of car driver'. Less important aspect appears to be the aspect 'cleanliness of the parking facility'.

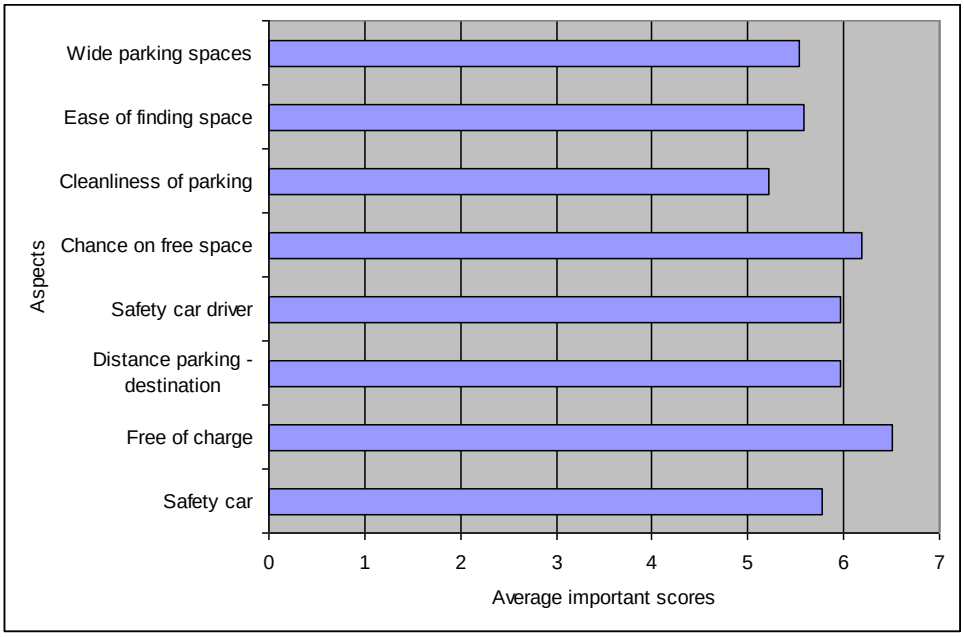

Figure 3 - Average important scores of parking related aspects

In addition, the average importance scores are related to three personal characteristics; gender, age, and education (Table 4). Based on the results of the independent sample t-test, the following relations are found. For gender, the importance scores for the aspects 'safety of car driver' and 'wide parking spaces' there is a significant difference between male and female respondents. Females evaluate both aspects as more important than males. In the case of the personal characteristic 'age' it was found that young respondents evaluate distance between parking and destination as more important than older respondents. Regarding education, respondents with a medium educational level evaluate the aspect 'free of charge' as more important than respondents with a high educational level. These results seem plausible and all are consistent with results of parking studies in residential and shopping environments.

Table 4 - Significant average important scores and personal characteristics

Aspect	*Characteristics*	*Average*	*Significance*
Safety of car driver	Male	5.82	0.004
	Female	6.53	
Cleanliness of the parking facility	Male	5.04	0.017
	Female	6.00	
Presence of wide parking spaces	Male	5.40	0.025
	Female	6.18	
Distance between parking - destination	Younger than 45 years	6.28	0.009
	45 years and older	5.61	
Free of parking charge	Medium educational level	6.71	0.031
	High educational level	6.29	

PARKING CHOICE MODEL

The stated choice data of the respondents are used to estimate a standard multinomial logit model. Effect coding was used to represent the effect of the characteristics levels on the choice probabilities of the parking alternatives. The choice alternative 'None of these' was used as base alternative. The estimation results are presented in Table 5.

Table 5 - Estimation results of overall parking choice model

Characteristics	*Levels*	*Part worth Utilities*	*Significance*
Constant		-0.6287	0.000
Contribution to parking costs	Nothing	1.7442	0.000
	1 euro per day	-0.5014	0.000
	2 euro per day	*-1.2428*	
Walking time parking to company	1 minute	0.6251	0.000
	2 minutes	0.0216	0.785
	3 minutes	*-0.6467*	
Presence of guarding at the parking	No	-0.3938	0.000
	Cameras	0.2141	0.013
	Extra lightning	*0.1797*	
Type of parking facility	Own parking lot	0.1907	0.050
	Public parking lot	-0.1707	0.063
	Public parking garage	*-0.0200*	
Chance on a free space at the parking	50 percent	-0.4719	0.000
	75 percent	-0.1003	0.281
	100 percent	*0.5722*	
Goodness of fit			
Rho square		0.277	
Adjusted Rho square		0.274	

With a McFaddens' pseudo r-squared value equal to 0.277 the model performs quite well. Looking to the constant of the model, it appears that in advance car drivers tend to chose for the base alternative 'None of these'. All investigated parking characteristics influence the attractiveness of parking facilities in a way that is expected. Based on the range of the

parameter estimates, it appears that parking costs is the most important characteristic influencing the attractiveness of parking facilities followed by walking distance between parking and company.

The attractiveness of a parking facility decreases when the car drivers' contribution to parking costs decreases. The same holds for walking time between parking and final destination. Car drivers prefer the presence of guarding at the parking. Cameras are more preferred than extra lighting. Car drivers prefer a company's parking above public accessible parking facilities. Only a 100 percent chance on a free parking space increases the attractiveness of a parking facility.

To get insight into the choice behavior of different groups of car drivers several logit models were estimated including average and contrast parameters. The *average parameters* represent the average effect of the characteristics of the parking information descriptions for both car drivers group 1 and group 2. The *contrast parameters* represent the differences between the distinguished groups of respondents. The contrast effects are calculated by multiplying the average effects with +1 (for group 1) and -1 (for group 2).

Table 6 - Significant (≥ 90 percent interval) contrast parameters per characteristic

Characteristics	*Attribute level*	*Part-worth utility*	*Significance*
Gender	*Costs*		
Group 1: Male	Nothing, group 1	1.6776	0.472
Group 2: Female	Nothing, group 2	1.8660	
	1 euro per day, group 1	-0.5666	0.077
	1 euro per day, group 2	-0.1222	
Age	*Walk time parking - destination*		
Group 1: 45 years and younger	1 minute, group 1	0.8063	0.012
Group 2: Older than 45 years	1 minute, group 2	0.4005	
	2 minutes, group 1	-0.1089	0.125
	2 minutes, group 2	0.1313	
Education	*Costs*		
Group 1: Medium level	Nothing, group 1	1.8886	0.080
Group 2: High level	Nothing, group 2	1.5566	
	1 euro per day, group 1	-0.5923	0.266
	1 euro per day, group 2	-0.3741	

First, respondents were divided into groups based on their personal characteristics: gender, age, and educational level. Table 6 presents the significant part-worth utilities per distinguished group at the 90 percent confidence level. In the case of gender, it appears that the contrast effect of the attribute parking costs is significant. Females prefer free parking more than male car drivers. Looking at the age of the car drivers, it appears that younger car drivers prefer shorter walking times more than older car drivers. This finding is a little bit surprising. However, when considering available time budgets of both groups of people, the finding is acceptable. Regarding differences in educational level, it appears that medium educated car drivers prefer free parking more than high educated car drivers. The latter two findings are in line with the findings regarding the importance scores.

CONCLUSIONS

Due to an increase in car use and a decrease in available private space increasingly more cars are parked in public spaces along roads or parking lots in industrial parks. In many cases, cars parked at public spaces cause problems for other types of traffic in the area such as through traffic and loading traffic. To manage these problems insights are required into car drivers' preferences regarding parking in industrial parks. The parking choice model as developed in this study provides some first insights. It appears that parking costs, walking time, and chance on free parking are the most important characteristics of a parking for car drivers when choosing a parking. It also appears that the effect of some characteristics is influenced by personal characteristics.

Planners of industrial parks can use the developed parking choice model to gain insights into the effect of suggested parking measures as far these can be described by means of the model variables. The extension of the parking model with contrast parameters show that is also necessary to make a detail description of the users of the industrial park. This holds especially for the age of the car drivers visiting the industrial park.

The model presented in this paper is just a first attempt to get insight into car drivers' preferences regarding parking in industrial parks. The search for an optimal parking choice model will be continued with additional characteristics and other industrial parks.

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