The Influence of Traveler Context on the Evaluation of Shopping Center Access

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Samenvatting

De invloed van de reizigerscontext op de evaluatie van de bereikbaarheid van winkelcentra

Dit paper beschrijft een studie naar de evaluatie van reizigers van de bereikbaarheid van winkelcentra. Met behulp van een Internetenquête is inwoners van Eindhoven gevraagd de bereikbaarheid van een regionaal winkelcentrum te beoordelen. De bereikbaarheid had niet alleen betrekking op drie verschillende vervoerwijzen (auto, fiets, en bus), maar had ook betrekking op verschillende aan deze vervoerwijzen gerelateerde voorzieningen zoals het aantal parkeerplaatsen, de kwaliteit van de fietsenstallingen, en de locatie van bushaltes. De verzamelde gegevens zijn geanalyseerd met behulp van multinomiale logistische regressie analyse. Het blijkt dat de evaluatiescores van de verschillende vervoerswijzen beïnvloed worden door de evaluatiescores van verschillende verkeersvoorzieningen en enkele persoons- en verplaatsingsgebonden kenmerken.

1. Introduction

The accessibility of shopping centers plays a considerable role in shopping center choice behavior. For example, Handy (1993) found significant relationships between accessibility levels and patterns of shopping travel. Frasquet *et al* (2001) investigated the influence of easy parking, easy access, and easy to take children along, on shopping center selection. They found a significant influence of these accessibility factors. Sinha (2000) concludes in his study that the accessibility and the perception of price/performance ratio are the main influences in shopping location choice. Also, Yavas (2003) investigated the importance of several accessibility variables and shopping center in the context of shopping destination choice. It appeared that shopping characteristics (price, variety, product selection) are most important choice variables, closely followed by accessibility related variables such as parking facilities, ease of access, and traffic flows. Despite all the efforts to study the influence of transport mode attributes on shopping travel, Ibrahim (2002) concluded that several transport mode attributes are often neglected. He suggested to extent the commonly used attributes such as travel time, distance and travel costs by attributes such as comfort and reliability of the transport mode.

As indicated by the above review of the literature, accessibility has been commonly measured in physical terms. Little attention has been paid to travelers' evaluation of accessibility. Although one would expect that these forms of accessibility are correlated, they may not be linear related. Moreover, one would expect that actual choice behavior us based on consumer evaluation of accessibility as opposed to researcher defined physical accessibility. It thus seems valuable to further examine the evaluation of accessibility. In this study, we assume that the evaluation of shopping centers' accessibility depends on contextual characteristics such as shopping trip characteristics and characteristics of the infrastructure in the vicinity of the shopping center (e.g., Simma & Axhausen, 2004). This paper intends to provide more insight into this relationship.

The remainder of this paper is organized as follows. First, attention is paid to previous studies on accessibility in general and accessibility of shopping centers in particular. Next, the adopted research approach is outlined including a brief description of the data collection. The descriptive and model analyses are described in section 4. The paper ends with the conclusions and some suggestions for future research.

2. Accessibility of shopping centers

In general, accessibility can be defined as the extent to which land-use and transportation systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport modes (Geurs & Van Wee, 2004). Handy (1993) divided accessibility into two parts. The first part concerns a transportation element that reflects the ease of travel between points in space as determined by the character and quality of service provided by the transportation system. The second part concerns a spatial element that reflects the distribution of activities such as stores and residences. The distribution is characterized by both the amount and the location of different types of activities. Accessibility is often expressed in travel distance, travel time or travel costs between two points for example home and shopping center. A review of several studies on shopping center probabilistic modeling in Frasquest *et al* (2003),

shows that most models represent accessibility of a shopping center only by Euclidean, objective, or subjective distance in meters or in minutes. Only a few studies included additional transport mode related characteristics such as the availability of parking or the access to parking facilities.

The number of studies that focus on the evaluation of accessibility in relation to a variety of transport mode characteristics is limited. For example, Ibrahim (2002) specified a list of transport mode attributes including comfort related aspects (protection from pollutants and weather, smoothness of ride, cleanliness of mode, temperature comfort of mode, and safety of travel), tension related aspects (absence from stress and congestion), effort related aspects (directness of travel, shortness of walking distance, absence of waiting time), value related aspects (travel time, enjoyment of travel, reliability of mode, and low cost), and distance related aspects (distance form home to shopping). Based on a weighted factor rating he found that comfort related transport mode attributes affect choice of shopping center for grocery shopping most (average score of 6.31 on a 7 point scale) followed by tension related attributes (average score 6.07) and comfort related attributes (average score 5.79). All three scores are higher than the highest shopping center characteristic.

The findings in previous accessibility oriented studies provide various but also contrasting insights in the relationship between accessibility and attractiveness of (shopping) destinations. It can also be concluded that little attention has been paid to the viewpoint of customers. Information concerning the evaluation of accessibility is limited. In 1999 Van der Waerden et al investigated the relationship between a set of conventional accessibility measures and residents' evaluations of accessibility. They found a weak relationship between the investigated measures and the resident's evaluation scores and suggested to investigate the individual differences of the residents in more detail. A subdivision in different transport modes might also improve the insights in resident's evaluation scores.

Based on the findings in the literature, the following research questions were formulated. The first question is: '*How do residents evaluate the accessibility of a regional shopping center for different transport modes*', and the second question is '*Are these evaluation scores influenced by personal and trip related characteristics?*'

3. Research approach and data collection

To get insight into the relation between the evaluation of accessibility and the traveler's personal and contextual characteristics, respondents were asked to evaluate the accessibility of the shopping center using a semantic differential scale with the bipolar statements 'very bad' (score 1) and 'very good' (score 7). Respondents were requested to evaluate the accessibility of the center separately for different transport modes: car, bike, and bus in case they are familiar with the transport mode in combination with the shopping center Woensel (Figure 1). In addition, respondents were asked to evaluate different characteristics of the infrastructure in the vicinity of the shopping center. Regarding the car, the following infrastructure characteristics had to be evaluated: number of parking spaces, location of parking facilities vis-à-vis origin of respondent and shops, the quality of entrances and exits, and the designation of parking facilities from public roads. Bike related infrastructure consisted of the quality of bicycle paths, number, location, and designation of bike stands. The number of bus stops, the location, the

design, and the walking routes between bus stops and shops constituted the bus related characteristics.

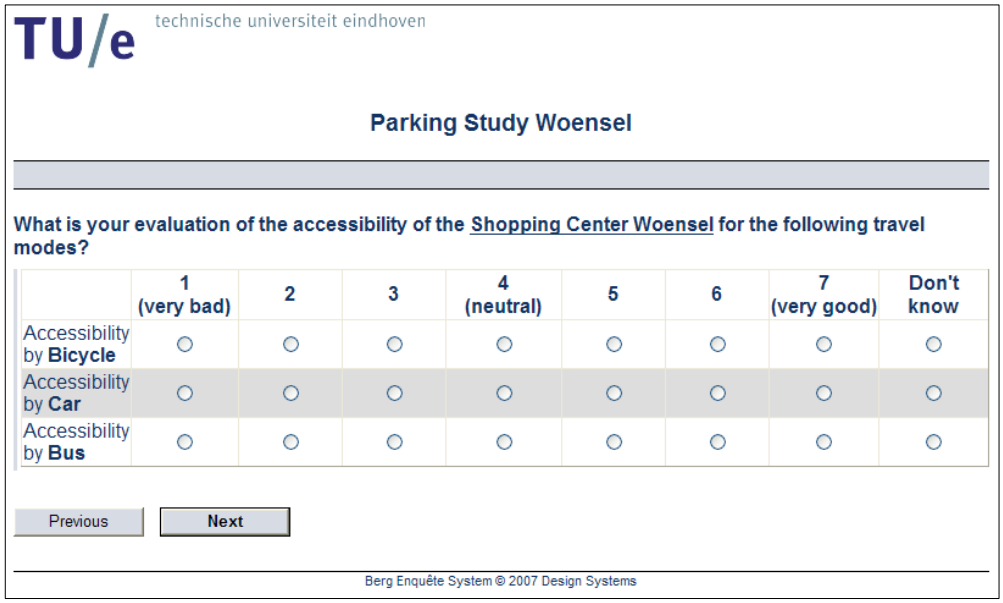

Figure 1: *Part of the internet questionnaire*

In addition to the evaluation scores, several personal and trip related characteristics were collected (see also Tables 1 and 2). Personal characteristics that were included in the questionnaire were gender, year of birth, education, residential location, household composition, number of cars in the household, availability of drivers' license, and the availability of a special car for challenged persons. Trip related characteristics cover visit purpose, visit frequency, visit day, and transport mode.

The data were collected in June 2007 as part of a larger study concerning residents' shopping behavior. In total 6000 invitation cards were distributed across households in various neighborhoods in the northern part of Eindhoven (see Figure 2). Special attention was paid to Shopping Center Woensel, the second largest shopping center of Eindhoven. The municipality planned to introduce paid parking in the surrounding of this shopping center which made it interesting to investigate residents' shopping behavior in relation to this shopping center. Residents were invited to participate in an Internet questionnaire. The questionnaire consists of questions about shopping visits for weekly and non-weekly purchases, evaluation of accessibility and parking situation, and personal characteristics. There was no incentive available to encourage residents to participate. In total 563 residents participated in the survey which makes a response rate of 9.4 percent. The data of 501 respondents could be used in this study.

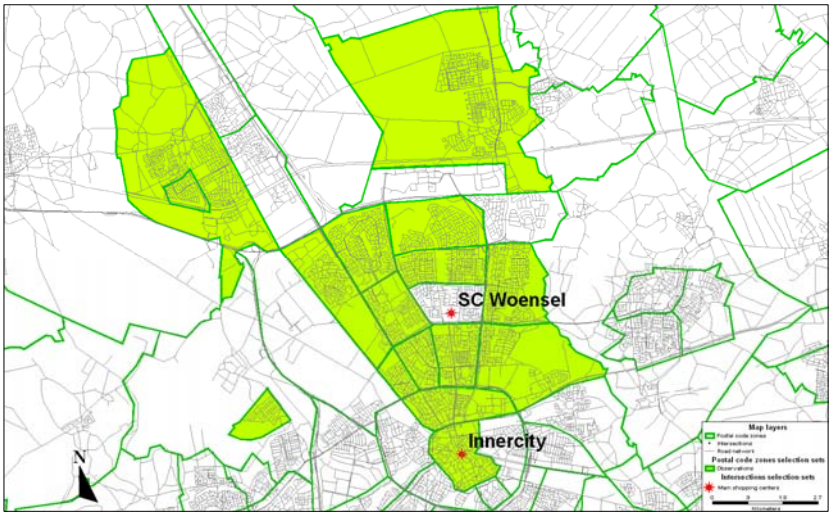

Figure 2: *Study area in Eindhoven North*

Table 1 presents the composition of the sample. It appears that for most characteristics there is an equal distribution across the distinguished characteristic levels. Only the group of respondents that have 1 car available is slightly larger than the group that has more than one car available.

Table 1: *Personal characteristics of the research sample*

Characteristics	*Levels*	*Frequency*	*Percentage*
Gender	Female	259	51.7
	Male	242	48.3
Age	Younger than 45 years	281	56.1
	45 years and older	220	43.9
Education	Medium level	275	54.9
	High level	226	45.1
Residential location -distance	More than 2 km from the Woensel shopping center	261	52.1
	1-2 kilometer from the Woensel shopping center	240	47.9
Residential location -direction	West of shopping center	261	52.1
	East of shopping center	240	47.9
Family composition	Household with children	221	44.1
	Household without children	281	55.9
Car availability	More than 1 car	171	34.4
	1 car	330	65.9
Total		501	100.0

Regarding the trip related characteristics it appears that most respondents visit the shopping center for non-daily purchases while almost half of them visit the shopping center also for weekly purchases (Table 2). Overall, respondents visit the shopping center for non-weekly purchases more frequent than for weekly purchases. The car is the most favorite transport mode. Most trips take place on weekdays. This holds for both weekly and non-weekly purchases.

Table 2: *Trip related characteristics of the research sample*

		Frequency	*Percentage*
Daily purchases	Yes	242	48.3
	No	259	51.7
Non-daily purchases	Yes	491	98.0
	No	10	2.0
Frequency of daily purchases	Less or equal to 45 times per year	307	61.3
	More than 45 times per year	194	38.7
Frequency of non-weekly purchases	Less or equal to 45 times per year	249	49.7
	More than 45 times per year	252	50.3
Commonly used Transport mode	Car	421	84.0
	Other	80	16.0
Visit day weekly purchases	No information	259	51.7
	Weekday	181	36.1
	Weekend	61	12.2
Visit day non-weekly purchases	No Information	10	2.0
	Weekday	354	70.7
	Weekend	137	27.3
Total		501	100.0

Table 3: *Average evaluation scores of accessibility and physical characteristics of facilities*

Evaluation score	*Average*	*Standard deviation*	*N*
Car			
Accessibility	5.55	1.559	494
number of parking spaces	4.14	1.771	486
location of parking facilities vis-à-vis origin and shops	5.25	1.419	489
Quality of entrances and exits	4.19	1.983	489
Designation of parking facilities from public roads	4.40	1.876	488
Bicycle			
Accessibility	5.80	1.453	435
Quality of bicycle paths	4.36	1.699	349
Number of bike racks	3.79	1.619	286
Location of bike stands vis-à-vis origin and shops	4.05	1.620	331
Designation of bike stands from public roads	3.47	1.562	297
Bus			
Accessibility	4.76	2.025	218
Number of bus stops	4.45	1.444	173
Location of bus stops vis-à-vis origin and shops	4.42	1.570	183
Design of the bus stop	4.35	1.342	169
Quality of walking routes between bus stop and shops	4.23	1.477	183

4. Descriptive analyses

The analysis consisted of two steps. In the first step, an overview of the respondent's evaluation scores is given. Special attention is paid to the spatial distribution of overall evaluation scores and the evaluation of the accompanying infrastructure characteristics. The results are described in this section. In the second part of the analyses, three ordinal

regression models are specified that describe the relation between the evaluation of the accessibility by car, bicycle, and bus, and the personal and trip characteristics of the respondents. The results are described in the next section.

Regarding the average evaluation scores it appears that most scores are above the general average score of 4 (Table 3). Respondents evaluate the accessibility by bicycle as highest (5.80) and the accessibility by bus as lowest (4.76). A paired sample t-test shows that the average evaluation scores differ significant. The car related aspect 'location' received the highest average evaluation score (5.25). In contrast, the designation of bike stand received the lowest average evaluation score (3.47). Also the evaluation of the number of bicycle racks is below average.

In addition, Figures 3, 4, and 5 present the spatial distribution of the average evaluation scores for the three involved transport modes: car, bicycle, and bus. The dark color (red) indicates a low evaluation and a light color (yellow) indicates a high evaluation score. Regarding the evaluation of the accessibility by car (Figure 3), it appears that the further away the origin of the traveler from the shopping center, the higher the evaluation scores is. Of course, this is a remarkable finding because a relation between evaluation scores and distance to the shopping center was expected. The pattern does not have a full symmetry. Residents in the two zones close to the shopping center evaluated the accessibility low which might be caused by the high difference between the straight line distance and distance over the road network. In the next section the evaluation scores will be related to several characteristics of the residents including distance to shopping center.

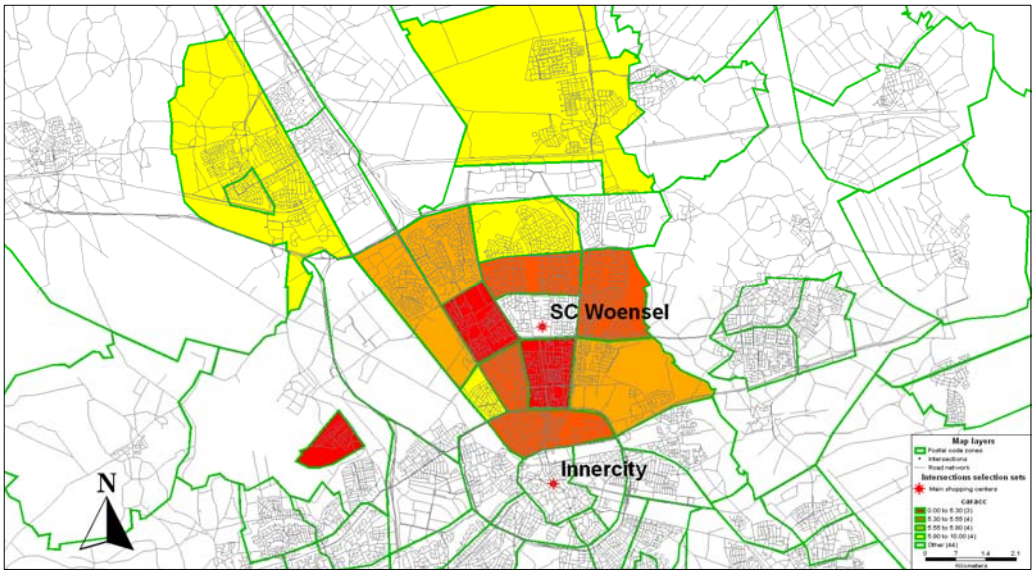

Figure 3: *Spatial distribution of average evaluation scores of transport mode Car*

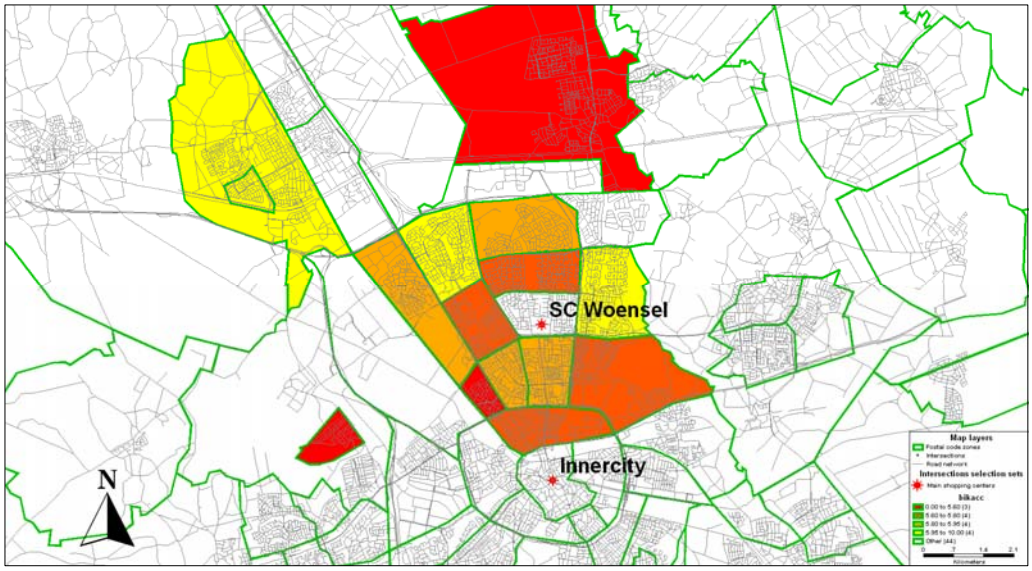

Figure 4: *Spatial distribution of average evaluation scores for transport mode Bicycle*

Regarding the spatial distribution of the bicycle related scores it appears that for almost all residential zones the accessibility evaluation scores are higher than for cars (Figure 4). This holds for the zones in the surrounding of the shopping center. Zones at some distance have a lower average accessibility score. Again, there is no symmetry in the pattern.

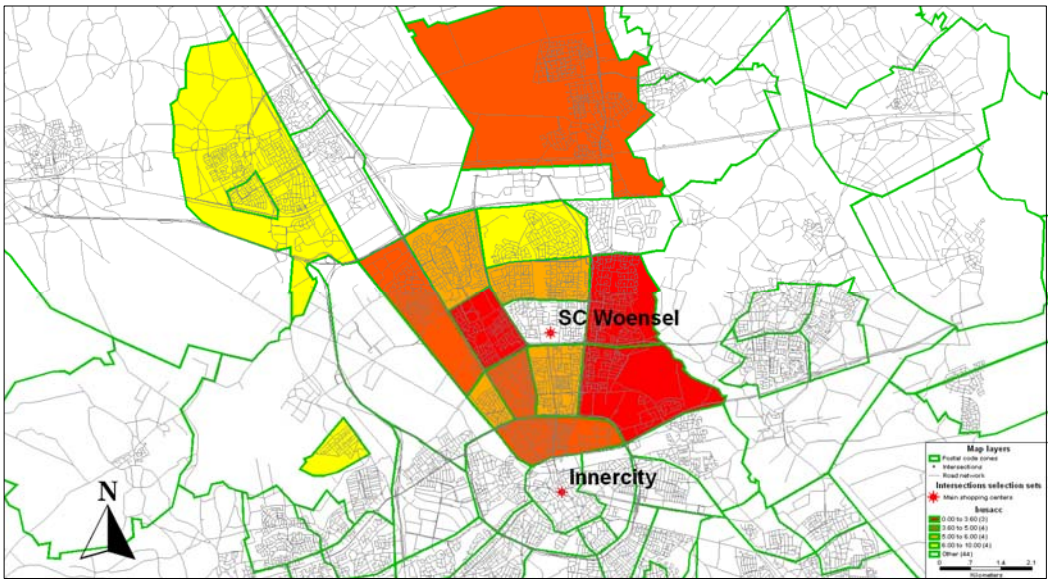

Figure 5: *Spatial distribution of average evaluation scores for Bus*

Finally, the residents' evaluation scores of the bus show low scores close to the center and high scores at some distance (Figure 5). In the vicinity of the shopping center the

difference between straight line distance and existing bus routes is large, while at some distance this difference is much smaller. This is mainly caused by good bus services between the neighborhoods at some distance and the shopping center.

5. Model analyses

To get insight into the relation between the overall accessibility evaluation scores of the different transport modes and the evaluation scores of the facilities, the personal and trip related characteristics, several ordinal regression models were estimated. The ordinal regression model is specifically developed for ordinal data where the distances between categories are unknown (e.g., Long & Freese, 2003). The ordinal regression model is commonly presented as a latent variable model. Defining y* as latent variable ranging between -∞ to ∞, the structural model is:

$$y^*_{i} = x_i \beta + \varepsilon_i \quad (1)$$

Where,

x_i represents a vector of physical characteristics for respondent *i*. In this study physical characteristics do not vary over respondents. This implies that subscript *i* can be dropped;

β represents a vector of regression coefficients.

The measurement model for binary outcomes is expanded to divide y* into J ordinal categories, where the cut-points τ_1 through τ_{J-1} are estimated.

$$y_i = m, \text{ if } \tau_{m-1} =< y^*_i < \tau_m \text{ for } m=1,2,\ldots..,J \quad (2)$$

The cut-points τ_0 and τ_J are set to -∞ and ∞ respectively. The probability of an observed outcome (y) for a given value of attribute vector x is the area under the curve (a normal or logistic distribution) between a pair of cut-points.

$$Pr(y=m|x) = F(\tau_m - x\beta) - F(\tau_{m-1} - x\beta) \quad (3)$$

Where,

F() is a normal or logistic distribution function.

Table 4: *Estimation results of ordinal regression models (significant effects only)*

Transport mode	*Characteristics*	*Parameter*	*Significance*
Car	**Thresholds**		
Rho-square:	1	0.273	0.526
0.159	2	1.126	0.004
	3	2.062	0.000
	4	3.236	0.000
	5	4.081	0.000
	6	5.772	0.000
	Evaluation scores of parking facilities		
	Quality of exits	0.274	0.000
	Number of parking spaces	0.328	0.000
	Location of parking facilities vis-à-vis shops	0.427	0.000
	Personal and trip characteristics		
	Gender -> Male	-0.425	0.016
	Educational level -> Medium	0.436	0.014
Bicycle	**Thresholds**		
Rho-square:	1	-2.841	0.000
0.134	2	-1.846	0.000
	3	-0.855	0.002
	4	0.459	0.068
	5	0.967	0.000
	6	2.090	0.000
	Evaluation scores of bicycle facilities		
	Cycle paths to bike stands	0.257	0.000
	Personal and trip characteristics		
	Educational level -> Medium	0.798	0.000
	Transport mode -> Other	0.522	0.035
Bus	**Thresholds**		
Rho-square	1	-0.372	0.320
0.127	2	0.405	0.256
	3	0.879	0.014
	4	1.950	0.000
	5	2.275	0.000
	6	3.246	0.000
	Evaluation score of bus facilities		
	Number of bus stops in the vicinity of shopping center	0.252	0.000
	Characteristics	1.176	0.000
	Position -> West of the shopping center		

The significant estimation results of the three estimated model are presented in Table 4. For each transport mode a separate model is estimated. In the models, the overall evaluation of accessibility acted as dependent variable. The evaluation scores of all separated mode specific characteristics (see Table 3) and the personal and trips related characteristics (see Tables 1 and 2) acted as independent variables. The model estimation process started with all evaluation scores and all characteristics. Non-significant scores and characteristics were removed from the model. For the model estimation, a logistic distribution is assumed. The values of the Rho-squares (1 minus the log-likelihood of optimal model divided by the log-likelihood of the model with only intercept) show that the performance of the separate models is acceptable.

The probability of the accessibility evaluation scores for cars is significantly influenced by the evaluation scores for quality of exits, number of parking spaces, and location of parking facilities, and the personal and trip characteristics gender and education. Regarding the effect of the evaluation scores of the parking facilities it appears that a higher part evaluation score results into a higher overall score. The probability of a higher overall evaluation score is lower for male respondents than for female respondents. In addition, the probability of a higher overall evaluation scores is higher for medium educated respondents than for highly educated respondents.

For bikes, the part evaluation score of cycle paths, and the personal and trip characteristics education level and transport mode, significantly influence the probability of the accessibility evaluation scores. Also in the case of bicycles, a higher part evaluation score results into a higher overall score. The probability of a higher evaluation score is higher for medium educated respondents and for respondents who do not use the car regularly for their shopping trip to the shopping center.

The probability of the accessibility evaluation scores for buses is significantly influenced by the part evaluation of number of bus stops, and the personal characteristics position of residential location vis-à-vis shopping center. Again, a higher part evaluation scores results into a higher overall evaluation score. Respondents who live at the west side of the shopping center have a higher evaluation score than respondents living east of the shopping center.

6. Conclusions

This paper describes the findings of a study of the evaluation of shopping center accessibility by car, bicycle, and bus. The average evaluation scores show that residents evaluate the overall accessibility of bicycles higher than the accessibility of cars and buses. Surprisingly, the part evaluation scores for bicycle facilities are lower than the part evaluation scores for car or bus facilities. This holds especially for the evaluation of the number of bike racks and designation of bicycle stands. Probably these characteristics are not related to the overall evaluation of the accessibility by bike.

The spatial distribution of the average evaluation scores shows for all transport modes that the closer the respondents live to the shopping center the lower the evaluation score of accessibility is. This finding shows that a traveler's evaluation score is not directly correlated with the distance between home and shopping centre. Traveler and trip related characteristics influence the evaluation scores more than distance. This finding is confirmed in the model analyses. Also the difference between straight line distance and distance over the road network plays a role. However, this finding does not hold for every residential zone. Some close to the shopping center located zones have a higher evaluation because of good car or bicycle infrastructure or bus services.

The relationship between the overall accessibility evaluation scores and the part evaluation scores of the facilities, the personal and trip related characteristics, is investigated using ordinal regression models. The transport mode specific models show that the probability of the overall evaluation scores is significantly influenced by the part evaluation scores and some personal and trip related characteristics.

The findings of this study show that accessibility is evaluated different by respondents depending on their evaluation of different infrastructure facilities such parking, bike stands and bus stops. To improve accessibility, planners have to pay more

attention to quality of exits of parking facilities, number of parking spaces, the location of parking facilities, the bicycle paths to bike stands, and the number of bus stop in the vicinity of shopping centers. Also, several personal and trip related characteristics such as gender, educational level, residential location, and most common used transport mode play have to be considered when setting up plans.

Future research will focus on the influence of physical characteristics of infrastructure on the accessibility evaluation scores. Also the implementation of the accessibility evaluation scores in travel choices such as destination, mode and route choice will be examined in more detail.

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