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EVALUATION OF ACCESS TO BUSINESS AREAS BASED ON INTELLIGENT TRANSPORT CONCEPTS

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Abstract

The interest in Intelligent Transport Systems (ITS) is growing. The relation between ITS and spatial development has not been widely studied yet. The possible impacts of three ITS-concepts on preferences for office locations were explored. Stated preference data were collected among managers of office-keeping businesses. Analyses indicate a significant contribution of the ITS concepts to the specified location preference model.

1. Introduction

The interest in applying various information technology based innovations in the transport system has grown rapidly during the past decade. These innovations focus on various aspects of transport. The general expectation is that these innovations contribute to a better performance of the transport system in terms of efficiency of infrastructure use, reliability of services, emissions, safety and comfort. Future perspectives go as far as the application of fully automated vehicle-driving (Van der Heijden & Marchau, 2002).

Evidently, such innovations generate many questions (e.g. Marchau & Van der Heijden, 2003), partly studied in the recent past. For example: the functional requirements of new devices (what aim is pursued), the technological complexity in relation to accuracy and reliability, the impacts (e.g. car driver behaviour and traffic safety) or the certification and market implementation. The way in which ITS might affect urban and regional developments has however hardly been studied so far, although considered important (e.g. Miller et al, 1997; Tayyaron & Khan, 2003). This was the reason for the authors to initiate an explorative empirical study on this issue.

This paper describes the set-up and the first results of this study. The study focused on the possible impacts of three integrated ITS concepts for road traffic on location preferences by managers of office-keeping businesses. Space limitation forces us to be rather brief in our description. In section 2 attention is paid to the set-up. Section 3 then summarises some of the results. The paper ends with conclusions in section 4.

2. Study set-up

As the nature of our study is very explorative, a first question is what our hypotheses are regarding the influence of ITS on location preferences. We know from location choice theory that companies prefer to be located at well-accessible spots. However, some companies prefer a good accessibility by car, while others also emphasise a good access by public transport. Moreover, location managers considering offices at different locations make trade-offs between the level of accessibility and variables such as costs,

image and flexibility in use of the office building. ITS-concepts are assumed to have influence on the accessibility of spots. The question then is whether office locations that are linked to an innovative transport system are more preferred than office locations without such a link, all other factors being equal. Based on previous studies we decided to compare the impacts of three integrated ITS-concepts on location preferences. Moreover, we assumed that due to future policy priorities and budget limitations, these concepts will not be implemented simultaneously at all road networks and places. In other words, we assume ‘implementation selectivity’ for the next decades. Consequently, inequality is generated between locations with and without an access based on ITS.

The second issue involved concerns the specification of the three different ITS-concepts. This selection was based on a morphological analysis (Argioli et al, 2004) and resulted in the following concepts.

- a. A highway-based network of lanes for automated vehicle driving. This concept is mainly focused on highly comfortable and reliable inter-urban traffic.
- b. An intra-urban network of lanes for automated busses, facilitating highly reliable public transport between the main areas within an urban agglomeration.
- c. A system of local automated transport (people mover), linking business areas to highway-related Park and Ride facilities.

All three concepts are characterised by a combination of dedicated infrastructure, vehicle requirements, real-time traffic optimisation and information provision to users.

The third question was: “how to measure the impacts of these ITS-concepts?”. This question implies the measurement of influence of their attributes on location managers’ preferences for different locations. It was decided to apply the so-called Hierarchical Information Integration (HII) Approach (Louviere, 1984). The HII approach is an extension of the traditional Stated Preference (SP) approach for cases where a large number of potentially influencing attributes need to be evaluated. The assumption is that the decision-maker will process information on different aspects of the problem in a hierarchical manner. By constructing different evaluation experiments for the different aspects as well as an evaluation experiment for bridging the evaluation of different aspects, one is able to construct an integrated model for a complex decision making problem. In our study, we decided to construct a separate SP experiment for accessibility and a bridging SP experiment including 5 attributes: nature of the building, rental prices, the flexibility of space use, the parking space and the overall accessibility. Overall accessibility in the bridging experiment was indicated in terms of an evaluation score. The link between these evaluation scores and real-world attributes was made in the separate SP experiment for accessibility. This experiment included also 5 attributes, including the distance to a train station, the distance to a stop at the automated bus lane, the distance to a stop for the people mover to the local P and R, the distance to the highway on/off ramp and the distance to the on/off ramp of the automated car lane. Hence, a mix of attributes measuring present and future (ITS-based) accessibility for car users and public transport users was included. Figure 1 summarises the attributes and indicates the applied levels.

The fourth aspect of the set-up was to collect evaluation data to specify the model. It was decided to send out a questionnaire. The measurement model was translated into a questionnaire, including some general data on the respondents and a description of the three concepts, illustrated by artist impressions of each concept. Further it included a set

of 8 accessibility profiles to be evaluated by the respondents on a 10-point rating scale (1 =very bad, 5=moderate, 10=excellent) for estimating the influence of different attributes of the selected accessibility attributes. Finally, a set of 18 profiles operationalizing the bridging experiment was included. Both the accessibility experiment and the bridging experiment included another 3 so-called hold-out profiles used for validation tests. The questionnaire was sent out in Summer 2005 to about 4800 addresses of office-holding companies in medium- sized cities in The Netherlands (150.000 – 300.000 inhabitants). The Chambers of Commerce supplied these addresses. In total 400 questionnaires returned, of which 368 were completed. This implies a response of about 8%, which is a satisfactory result, given the response rate reported in similar studies among businesses. Moreover, the amount of completed questionnaires is sufficient to calibrate the location preference model. The next section reports on the results.

Figure 1: overview of experiments, attributes and attribute levels

Bridging experiment		Accessibility experiment	
attributes	levels	attributes	levels
1. Office building type	a. Old mansion in respectable neighbourhood b. Functional building in residential area c. Modern building in office park/boulevard	1. Motorway on/off ramp	a. 1.5 km; b. 6 km
2. Internal use concept	a. Separate rooms b. Multi-purpose office rooms c. Separate rooms + office garden	2. Train station	a. 250 meter; b. None
3. Rental costs per m2/year	a. € 90 b. € 130 c. € 170	3. Automatic bus stop	a. 250 meter; c. None
4. Parking space: number of lots per 100 employees	a. 10 b. 30 c. 50	4. People mover to P&R	a. 250 meter; d. None
5. Accessibility judgment (10-scale rating)	a. 4 b. 6 c. 8	5. On/off ramp automatic car lane at highway	a. 1.5 km; b. None

3. Results

First, the 368 respondents on average scored a 4.98 (st. dev. 1.56) on the 6-point scale measuring the degree of influence they have within the company on location decisions. Hence, it seems valid to assume that the organisations' location preferences can be based on the data provided by the respondents. Further response group characteristics are summarised in Table 1, indicating a good variety regarding business characteristics.

Secondly, we were interested in the respondents' general opinions on the three concepts. This was measured on a 6-point scale, 6 being a score for (a) very realistic / plausible or (b) definitely an improvement. The respondents (see table 2), on average, tend to be positive regarding both questions for all three ITS-concepts. They consider the automatic bus lane network concept slightly more realistic and expect slightly more contribution of this concept to the improvement of the accessibility of their urban/regional environment than the two other concepts.

Table 1: Characteristics of response group

	Absolute (n=368)	Relative (100%)
<i>Present Office Building Type</i>		
Old mansion in respectable neighbourhood	157	43 %
Functional building in residential area	108	30 %
Modern building in office park/boulevard	100	27 %
<i>Branch activity</i>		
Financial services	64	18 %
Facilitating services	92	26 %
Consultancy	153	43 %
Non-profit	45	13 %
<i>Company size (employees at office)</i>		
0-10	186	51 %
10-50	145	39%
51-100	22	6 %
100-1000	16	4 %

Table 2: Average opinion on the three ITS-concepts

	Mean (n=368)	Standard deviation
<i>Automatic car lane along highway network</i>		
Is this a realistic transport concept?	3.81	1.46
Improvement of accessibility in your region?	3.97	1.37
<i>Automatic bus lane network</i>		
Is this a realistic transport concept?	4.26	1.38
Improvement of accessibility in your region?	4.05	1.37
<i>People mover + P&R</i>		
Is this a realistic transport concept?	3.91	1.46
Improvement of accessibility in your region?	3.85	1.34

Thirdly, the extent to which the three ITS-concepts contribute to the overall evaluation of the accessibility of office locations was studied. Regression analysis was used to estimate a main-effects preference model, assuming decision makers simply add their utilities of separate attribute levels (i.e. part-worth utilities) to arrive at overall utilities. To that effect, the attribute levels were effect-coded, implying that the intercept of the regression equation is equal to the average rating whereas the regression coefficients represent the part-worth utilities of the attribute levels as deviations from this average rating. Table 3 presents the results. Column 2 of Table 3 shows the part-worth utilities of the included attribute levels as well as the average utility. Column 3 shows the significance of this contribution. Column 4 indicates the importance of an attribute, calculated by the difference between the two part-worth utilities of that specific attribute.

Table 3 indicates that the estimated part-worth utilities are in expected directions. Two conventional transport modes have the largest influence on the accessibility of an office location. The proximity of a motorway on/off ramp appears to be slightly more important than the proximity to a train station. Nevertheless, the ITS-concepts each appear to have a significant contribution to the accessibility of a new office location. The automatic bus lane network has somewhat more influence than the two other ITS-concepts. These values imply that an office location with the nearest access to all the 5 attributes, generates a total (average) accessibility utility of $5.80 + 0.68 + 0.56 + 0.39 + 0.27 + 0.27 = 7.97$.

Table 3: Part-worth utilities of five transport concepts

attributes	Part-worth utility	Significance	Importance (rank-order)
Average utility	5.805		
Motorway on/off ramp			1.356 (1)
0) 1.5 km	0.678	0.001	
1) 6 km	- 0.678		
Train station			1.114 (2)
0) 250 km	0.557	0.002	
1) 3 km	- 0.557		
Automatic bus stop			0.772 (3)
0) 250 meter	0.386	0.004	
1) none	- 0.386		
People Mover to P&R			0.542 (4)
0) 250 km	0.271	0.007	
1) none	- 0.271		
On/off ramp automatic car lane			0.538 (5)
0) 1.5 km	0.269	0.007	
1) none	- 0.269		

Table 4: Part-worth utilities for general location attributes

attributes	Part-worth utility	Significance	Importance (rank-order)
average utility	4.939		
Parking space (per 100 employees)			1.420 (1)
0) 10	-0.710	0.000	
1) 30	0.059	0.288	
2) 50	0.710		
Accessibility judgement (10-point scale)			1.256 (2)
0) 4	-0.628	0.000	
1) 6	0.019	0.713	
2) 8	0.628		
Rental/purchase costs per m2/year			0.992 (3)
0) € 90	0.496	0.000	
1) € 130	0.056	0.312	
2) € 170	-0.496		
Internal use concept			0.461 (4)
0) Separate rooms	-0.281	0.001	
1) Multi-purpose office rooms	0.180		
2) Separate rooms + office garden	0.101		
Office building type			0.248 (5)
0) old mansion, respectable neighb.hood	-0.008	0.880	
1) functional building, residential n.h.	-0.120	0.055	
2) modern building, office park/boulevard	0.128		

Finally, Table 4 describes the final general analyses of the collected data, regarding to the location profiles of the HII experiment. It appears that the availability of parking space is the most important attribute in this context. The non-significance of the second part-worth utility implies that the second value does not significantly deviate from zero. Hence the utility function is to be considered as determined by two values and thus linear. This implies that an increase in the number of parking lots per 100 employees from 10 to 30 increases utility to the same amount as increase from 30 to 50 parking lots. The second important attribute concerns the overall accessibility of the office location. Again, the utility function can be interpreted as linear, implying that an improvement of the overall score from 4 to 6 increases utility to the same amount as increase from the overall

score from 6 to 8. It is again memorised that these attribute levels were designed as a decision construct linked to the previously described SP experiment. Given space limitation, we do not discuss the other attributes or analyses of subgroups of the respondents. It is referred to other (future) publications by the authors for more detailed analyses. Note that the fifth attribute appears not to be significant at an aggregate level.

4. Conclusions and discussion

We are interested in the possible impacts of ITS on urban and regional developments. Such developments are, among others, influenced by changes in office locations. These changes are triggered by market dynamics, on the one hand influenced by decisions of office-area and real estate developers and on the other hand by preferences of their clients, being the office-keeping companies. Accessibility is known to be of major importance in this market. Whether ITS-based changes in accessibility might in the future be of influence on this market has not been researched before, but is of importance for the question where to selectively invest in innovations in the transport system. The results of the present study indicate that indeed office location manager do consider ITS-based innovations in the transport system in the future plausible and contribute to a better accessibility. Further, we found that proximity to these concepts significantly influences the preference for office locations. Especially, the influence of a network of intra-urban lanes for automated busses, a concept that shows similarities with the Phileas project in the Dutch city of Eindhoven, on location preferences seems relatively strong. At least somewhat stronger than a concept focusing on local transport with a people mover to highway-related P&R facilities or the proximity to a network of dedicated lanes for automated car transport at the level of a highway network. The next step in our study is to further explore the collected data in detail and to test the validity of the estimated model.

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References

- Argioli, R., R. Van der Heijden & V. Marchau (2004): ITS policy strategies for urban regions: a creative exploration, in: *Supplement to the 8th TRAIL Congress 2004 Proceedings*, TRAIL Communications, TRAIL Research School, Delft, The Netherlands
- Louviere, J. (1984): Hierarchical information integration: a new method for the design and analysis of complex multi-attribute judgement problems, *Advances in Consumer Research*, vol. 11, pp. 148-155
- Marchau, V. & R. van der Heijden (2003): Innovative methodologies for exploring the future of automated vehicle guidance, *Journal of Forecasting*, vol. 22, pp. 257-276
- Miller, M., A. Bresnock, S. Shladover (1997): Regional mobility impacts assessment of highway automation, in: Ioannou (ed.): *Automated Highway Systems*, Plenum Press, New York, pp. 293-311
- Tayyar, M. & A. Khan (2003): The effects of telecommuting and intelligent transportation systems on urban development, *Journal of Urban Technology*, vol. 10 (2), pp. 87-100
- Van der Heijden, R. & V. Marchau (2002): Innovating road traffic management by ITS: a future perspective, *International Journal of Technology, Policy and Management*, vol. 2 (1), pp. 20-39