The Choice of Park & Ride Facilities: An Analysis Using a Context-Dependent Hierarchical Choice Experiment[1]

Ilona Bos, Rob van der Heijden, Eric Molin and Harry Timmermans[2]

[November 2003]

Word count: 5913 + 6*250 = 7413

Abstract. Park and Ride facilities have been proposed in several countries to alleviate the accessibility problems in cities. Despite growing accessibility problems, these facilities do not seem to attract the expected number of car drivers and are under-used. In an attempt to measure consumer evaluations of the attributes of Park and Ride facilities, a stated choice experiment, based on the method of hierarchical information integration, was conducted in the city of Nijmegen, The Netherlands. This paper documents the major results of this study, which differs from previous research in that a large range of attributes is examined, including accessibility of the facility, the quality of the facility, and the features of additional transport. In addition, context variables affect the decision-making process of car drivers such as weather, having luggage and travel purpose were incorporated in the study design. The results indicate that safety, quality of the public transport and relative travel times by transport modes are key attributes to the success of P&R facilities. Contextual variables seem to have only a minor impact.

1 INTRODUCTION

Growing car use in and around cities in industrialized countries has lead to increased accessibility problems, reflected in traffic jams and parking problems. To alleviate this problem, Park and Ride (P&R) facilities on the outskirts of cities, where car drivers can switch to public transport, have been proposed in the Netherlands and in several other countries. P&R are supposed to combine the advantages of a high-quality public transport system in densely populated cities with those of the car in more thinly populated areas. However, despite the growing accessibility problems, P&Rs do not seem to attract the expected number of car drivers.

In an attempt to identify the reasons why P&Rs are under-used, several evaluation studies have been conducted in the Netherlands (e.g. [1], [2], [3], [4]). Such evaluations however face the challenge of how to collect the data and how to infer the decision-making process of car drivers. The decision whether or not to choose the facility is quite complex, and

---

[1] Paper accepted for presentation at the 83rd Annual Meeting of the Transportation Research Board, January 2004, Washington, D.C., Commission A1E03 Committee on Intermodal Transfer Facilities.

[2] Ilona Bos and Eric Molin are respectively Ph.D. Student and Assistant Professor at the Department of Transport Policy and Logistics Organization, Delft University of Technology, Faculty of Technology, Policy and Management, the Netherlands, fax: +31 15 2782719, e-mail: d.m.bos@tbm.tudelft.nl; e.j.e.molin@tbm.tudelft.nl. Rob van der Heijden is Professor of Human Geography and Spatial Planning, University of Nijmegen, Nijmegen School of Management, the Netherlands, fax: +31 24 361 1841, e-mail: r.vanderheijden@nsm.kun.nl. Harry Timmermans is Professor of Urban Planning at the Faculty of Architecture, Building and Planning, Eindhoven University of Technology, the Netherlands, fax: +31 40 247 5882, e-mail: eirass@bwk.tue.nl.

This paper originates from the research program "Seamless Multimodal Mobility" of TRAIL Research school (TRAnsport, Infrastructure and Logistics).

involves at least the accessibility of the facility, the quality of the facility, the features of additional transport and the availability of information. Furthermore, certain context variables affect the decision-making process of car drivers, for example weather, having luggage and travel purpose. Given this large number of attributes and context variables, it is not easy to disentangle the effects of all these attributes on the choice decision.

Past research has typically relied on (a combination of) revealed preference (RP) and stated preference (SP) approaches. For example, Van der Heijden and Molin [4], Lo and Lam [5], Guan and Nishii [6], and Ghali *et al* [7] used an SP experiment, but their results are of limited use as they only varied time and costs attributes. Van der Waerden *et al* [8] also applied an SP approach, using a larger but a still limited set of attributes. Bradley and Kroes [9] estimated joint RP/SP models, but also considered only time and costs attributes. Polydoropoulou and Ben-Akiva [10] used the same approach, but added comfort attributes (probability of a seat and number of transfers) in their study. Finally, Heijden *et al* [1], incorporated in their SP study the probability and the costs of parking at their destination, but supervision and safety aspects were not taken into account.

The scope of previous studies therefore seems too limited to fully understand the influence of the large set of potentially relevant attributes. As a consequence, developing and planning P&R facilities cannot be fully based on the results of these studies. To that effect, the effect of a more complete set of attributes describing P&R facilities, the quality of additional public transport and the characteristics of destination should be measured. In addition, modal choices may be dependent on temporal conditions such as weather or transporting luggage, hence these effects of these context effects should be studied as well. As only a relatively small number of P&R facilities have been built, the RP approach will not provide the requested insight due to the limited variety in P&Rs. Therefore, the SP modeling approach seems the only possible approach at the current state of affairs. SP approaches rely on the preferences or choice expressed by respondents for hypothetical choice alternatives. Because the researcher has complete control over the covariance between attributes of the choice alternatives, a preference or choice model can be estimated efficiently. However, the application of SP modeling approach poses problems as a large number of attributes influences P&R choice, while traditional stated preference experiments can only handle a limited number of attributes.

The aim of this paper is to present the results of a stated choice experiment to model P&R choice in the city of Nijmegen in the Netherlands. Because of the large number of potentially influencing attributes, the Hierarchical Information Integration (HII) approach, originally proposed by Louviere [11], was applied. The HII approach is an extension of the traditional information integration approach (better known as stated preference in transportation research) and allows one to handle a large number of attributes. This approach has been successfully used in other applications before, including the choice of retail facility [12], recreation destination choice [13], residential choice ([14], [15]), and freight mode choice [16]. To the best of the authors' knowledge, this is the first application of HII to model passenger mode choice behavior.

This paper is organized as follows. First, the method of hierarchical information integration is briefly introduced to those readers being not familiar with this methodology. Next, the research design and data collection are discussed, followed by a discussion of the analyses and results. Finally, some conclusions are drawn and implications for park and ride policies and the planning and developing of such facilities are discussed.

2 RESEARCH DESIGN

2.1 Methodology: The Hierarchical Information Integration approach

Louviere [11] proposed the HII approach as a way to deal with complex decision problems that involve many attributes. He assumed that when individuals are confronted with decisions that involve many attributes, they process information in a hierarchical manner. Individuals are assumed to first group the attributes into higher-order decision constructs. Then they evaluate each construct separately, and finally integrate these evaluations to arrive at an overall preference or choice. In line with these assumptions, a separate experiment for each decision construct is constructed to estimate the contribution of each attribute on the evaluation of the corresponding higher order decision construct (see Figure 1). In addition, a bridging experiment is constructed to estimate how the evaluations of the higher order decision constructs are integrated to arrive at an overall preference ([11], [17]). Based on the responses observed in each experiment, a utility function can be estimated for each decision construct. Furthermore, an overall integrative model can be estimated which links the separate construct evaluations with the overall evaluation or choice.

2.2 Construction of the experiments

The first stage in applying the HII approach is concerned with the grouping of the total set of potentially relevant attributes into logical or at least useful decision constructs. In previous studies, the grouping of attributes has typically been a subjective decision of the researcher, based on a literature review or logic. Because such subjective decisions may not reflect the grouping process of travelers, we decided to conduct a separate project that aimed to identify the higher order constructs used by travelers when choosing or evaluating P&R facilities and the relationships between attributes and higher order decision constructs. The results of this project are reported in detail elsewhere ([18], [19]). Using Likert scales, and Multidimensional scaling, five decision constructs were identified.

The first construct is ‘*parking*’, and included attributes about information, the chance to find a parking place, the possibility of reserving one, and the walking distance from car to public transport. The second decision construct was labeled ‘*P&R facilities’*, and was defined by safety attributes such as supervision at P&R, a lighted pedestrian route and liveliness at P&R, and attributes about additional provisions such as a heated waiting room or a supermarket. The third construct is ‘*public transport’*, and was composed of attributes about the reliability of public transport and attributes about comfort. Finally, the constructs ‘*time*’ and ‘*costs*’ were identified. The former construct was related to attributes such as time needed to look for a parking place at destination, the amount of traffic in the city and the extra travel time from principal road to P&R. The latter construct was defined by attributes such as total costs of transferring, costs of road pricing and parking costs at destination.

A straightforward application of the HII approach would thus result in six experiments, one for each of the five decision constructs, and one integrative, bridging, experiment. However, as the total task load for respondents may become too high, the number of experiments and the number of attributes was further reduced by: (1) deleting the attributes whose important scores were very low in the preliminary research, (2) assuming that modern P&R designs would always satisfy certain attribute levels, making several attributes superfluous and (3) a closer inspection of the likely covariance of attributes, allowing us to disregard some attributes. These considerations led to the following simplifications. First, as only a single attribute of the original ‘parking’ construct attributes was left, this attribute was merged into the ‘P&R facilities’ construct. In some sense, this operational decision was also supported by the MDS solution showing that the parking and the P&R facility constructs were close in the MDS solution. Moreover, it was decided not to construct experiments for the ‘time’ and ‘costs’ constructs. Construct experiments for time and costs respectively would imply that respondents had to trade off different time components in the time experiment and different cost components in the cost experiment. In previous research [4] evidence was found that respondents simply added the different time components to an overall time and the different cost components to overall costs, and responded only to these overall time and costs, thus without differently weighing the various components. Assuming this finding can be generalized, separate time and cost experiments would not reveal any relevant insight and only extent the respondents’ task with response fatigue as a likely consequence. Instead, the time and costs decision constructs were included as total time and total cost attributes in the choice experiment. One might argue then that this is not a bridging experiment in the sense that the time and costs attributes are single attributes and no construct evaluations.

These simplifications implied that three experiments were constructed. One experiment to estimate the contribution of the underlying attributes to the 'P&R facilities' decision construct, another experiment for estimating the influence of attributes on the 'public transport' construct, and the bridging experiment.

The construction of these experiments involved combining the underlying attribute levels into profiles. In order to limit the number of profiles, the 'smallest orthogonal fraction' of the full factorial design was chosen for each experiment. This operational decision implied that none of the interaction effects could be estimated. Thus, it was assumed that the part-worth utilities of each attribute levels defining a particular decision construct are added to obtain the overall preference for that decision construct. This decision resulted in 18 profiles for the P&R facility experiment and 9 profiles for the public transport experiment. Respondents were asked to evaluate each profile on a ten-point rating scale, ranging from very unattractive (1) to very attractive (10).

In addition to the two construct experiments, a bridging experiment was constructed. Originally, Louviere [11] framed this experiment as a preference task, but Timmermans ([20], [21]; see also Louviere and Timmermans, [13]) generalized this approach into a choice task. The latter approach was followed in this study. It was assumed that travelers have three options to travel to the city center. They can either drive by car from door to door, they can use P&R (i.e. drive by car to the outskirts of the city and then switch to public transport), or they can use public transport for the whole trip. Consequently, choice sets consisted of a P&R alternative, a car alternative and a public transport alternative. The P&R alternative was described by the respondent evaluations of 'quality of additional public transport', 'quality of P&R facilities', 'extra total time needed when using P&R' and 'extra total costs when using P&R'. The car alternative was described by 'extra total time when using the car' and 'extra total costs when using the car'. Extra time and extra costs are defined as additional time and costs as compared to a car trip without delays or parking fees. Finally, the public transport alternative was treated as the base alternative, which does not vary between the choice sets. As for the public transport alternative, travelers had to assume that it is free of delays.

The choice sets and choice alternatives were simultaneously constructed from a fractional factorial design, resulting in 18 choice sets. The four P&R attributes and the two attributes for the car alternative were assigned to different columns of that design, ensuring that the attributes are not only orthogonal within but also between the P&R and car alternatives. The public transport alternative was added to each choice set as a base alternative. Respondents were asked to choose the single alternative in each choice set that they liked best.

As the choice may be different for certain conditions, in addition, the following context variables are varied in the experiment; (1) weather, varied in dry and rainy weather, (2) travel purpose, varied in working purposes and recreational purposes (3) luggage or no luggage, (4) car-pooling or not, and (5) the time of the day, varied in day hours and evening hours. A fractional factorial design of these five attributes was constructed resulting in eight context situations. The choice design was nested under each of the eight situations. As a consequence, eight different versions of the choice experiment were constructed, evaluated by different respondents.

2.3 Sampling method and sample characteristics

Data to estimate the model were collected in the city of Nijmegen, a medium-sized city, situated in the east of the Netherlands. This city was selected because it is well known for its accessibility problems, especially from the north side due to the location directly along the river Waal. From that side, the city is only reachable by the 'Waalbridge', which leads to a densely stream of traffic. Parking problems in the center of Nijmegen further reduce accessibility of the city. It is in this area that car drivers who visit Nijmegen for work or free-time purposes were approached. Hence, the target group was formed by car drivers who live outside the city of Nijmegen and work or spend their free time in Nijmegen on a regularly basis.

The target group was approached in two different ways. First, in the city center of Nijmegen and in another major shopping center in Nijmegen car drivers who just parked their car were approached by interviewers and asked whether they were willing to fill out a questionnaire. If they said they would, interviewers checked whether they belonged to the target group, and if so, they were asked to provide their home address. The questionnaire was mailed to this address, together with a return envelope. Secondly, car drivers working in Nijmegen and living outside the city were approached through their company. Companies could choose between sending an email address with a link to an Internet questionnaire or sending a paper version by mail to the home address. The data collection took place in the second half of June 2002.

In total, 805 people filled out the questionnaire; 500 completed the paper version, and 305 the questionnaire on the Internet. The characteristics of the response group are listed in Table 1, showing that (1) as many men as women filled out the questionnaire; (2) as many highly-educated people filled out the questionnaire as middle- or lower-educated people; (3) most respondents were between 30 and 50 years old, but the younger and older groups were substantially represented as well; (4) Most respondents have a (compact) middle class car; (5) Almost all respondents have owner-occupied cars; (6) Most respondents have no experience with P&Rs; and (7) 7 out of 10 respondents have experience with public transport in general. From these results, there are no reasons to believe it was a rather specific group of respondents.

3 ANALYSIS AND RESULTS

A preference function was estimated for each construct design separately. In addition, a choice model was estimated using the data of the choice experiment. The results are discussed in the following sub-sections.

3.1 Quality of P&R facilities

Regression analysis was used to estimate a main-effects only preference model. To that effect, the attribute levels were effect coded. This implies 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.

The results of the model based on aggregated data are presented in Table 2. Note that the relative importance of the attributes was calculated as follows. First, the difference is calculated between the maximum en minimum utility by using the maximum and minimum attribute value per attribute respectively. Then, all these differences are summed up. And finally, the share of the difference of each attribute to this sum is calculated and expressed in percentages. The R^2, being a measure of the goodness-of-fit of the model, is equal to 0.996, which means that the model has an excellent fit. However, when interpreting these outcomes, one should realize that the degree of freedom is small.

Table 2 clearly shows that the three attributes related to the general notion of (social) safety are more important than the facility attributes. ‘Supervision at P&R’ is obviously the most important attribute. By placing cameras at the P&R facility, attractiveness increases by almost one point, which is a substantial increase considering the fact that a ten-point scale has been used. The additional presence of supervisors also increases the attractiveness, albeit to a much smaller extent. Clean, well-maintained P&Rs also positively contribute to the evaluation of P&Rs, while graffiti affects utility less negatively then might be expected. As expected, surveyable and lively pedestrian routes also increase P&R attractiveness.

Of the facilities attributes, the attributes additional provision, walking time and waiting room are almost equally importance, while paying facilities are clearly least important with none of the part-worth utilities significant at the 5% level. However, paying facilities are not really unimportant, but additionally estimated individual models (not presented in this paper) reveal that preferences differ widely between the respondents with the result that effects averaged out at the aggregated level. The data indicates that the availability of a supermarket influences P&R evaluation positively. Furthermore, it is remarkable that 'walking distance from car to public transport' appears to be of relatively minor importance to the traveler. Apparently, travelers are not really unwilling to walk a few minutes. Finally, as expected, a heated waiting room adds to the overall utility. In general it can be concluded that all part-worth utilities were in anticipated direction, giving face validity to the estimated model.

3.2 Quality of additional public transport

Linear regression analysis was also applied to estimate the influence of the relevant attributes on the evaluation of the public parking attribute. The results of the model based on aggregated data are presented in Table 3. Because a saturated model was estimated, the model perfectly fits the data and therefore significance levels are not provided.

Table 3 clearly shows that 'certainty of a seat' is the most important attribute. An explanation might be that the car drivers who completed the questionnaire are used to have comfort in their cars. The second most important attribute is 'number of transfers'. The improving transfers by going from a none guaranteed to a guaranteed transfer increases utility by the same amount as going from a guaranteed transfer to zero transfers. Next in importance is 'frequency of public transport'. This result suggests that if the frequency decreases below once every 10 minutes, utility decreases more rapidly. By far the least important attribute is 'mode of transport'. However, further individual level analysis of the data reveals that the preference differences average out between the respondents at the aggregated level.

3.3 Choice between P&R, car and public transport

Having estimated the part-worth utility functions, next a multi-nominal logit model of P&R choice was estimated. To that effect, the relative choice frequencies were aggregated across respondents for each choice set. In the choice model, not only the attributes are considered describing the P&R and car alternatives but also the influence of context variables was taken into consideration. In this way, not only the part-worth utilities for the attributes were derived but also for the context variables.

The Rho-square of this model is equal to 0.793, which suggests that the estimated model performs well. Comparing the model with context variables (LL(B) = –822.797) with the model without context variables (LL(B) = –1010.69) suggests that context variables significantly affect the choice of P&R facilities as a Chi^2 value of 375.8 can be calculated with a p-value of 0.000. The part-worth utilities for the attributes, together with significance levels and importances scores are presented in Table 4, those for the context variables in Table 5.

Because public transport constituted the base alternative, travelers' utility of public transport is zero by definition, and other alternatives are compared to public transport. The positive value of the intercepts of both P&R and car suggests that, on average, these two alternatives are preferred to the public transport alternative. The intercept of car is higher than the intercept of P&R, indicating that, on average, car is more preferred to P&R.

When examining the part-worth utilities and the importance scores of the attributes, it seems that the time attributes have the highest impact on choice behavior. Taken into account the range differences, extra time when using P&R (utility of each minute extra travel time per P&R decreases with 0.053) influences choice behavior slightly more than extra time using car (utility of each minute extra travel time per car decreases with 0.049). Additional analyses were conducted to test whether this difference is significant by testing whether the contrast, indicating the difference in time valuation for car and P&R, is significant. The results of this additional analysis indicated that extra time when using P&R influences the decision-making process in a larger degree than the extra time when using car.

Looking at the part-worth utilities of the time attributes, an increase in extra time per P&R of more than 10 minutes affects P&R choice more negatively than an increase of less than 10 minutes, while the increasing extra time of the car alternative practically linearly influences utility. Thus, when using P&R takes more than 10 minutes extra time, time loss due to traffic jams will cause a lower percentage of car drivers to switch to P&R than in case extra time of using P&R is quite limited.

For the costs attributes yields that each additional euro for using P&R influences choice behavior more negatively than a comparable increase in car costs (utility of each euro extra travel costs is for P&R 0.249 and for the car 0.173). Furthermore, utility decreases linearly with increasing P&R costs. This is not true for the case of increasing car costs: the increasing car costs above € 3.50 affect utility more than below € 3.50.

Finally, the quality of P&R facilities has a slightly higher impact on P&R choice than PT quality (utility of each value extra quality is for P&R 0.240 and for public transport 0.174). For each construct yields that utility increases linearly with increasing quality of P&R and quality of public transport. Hence, every increase in quality of both constructs in any part of the evaluation scale affects choice in the same way.

3.4 Effect of context variables on the choice

Table 5 shows the effects of context variables on mode choice. In the first two columns of the table, the effects of the context variables on the P&R alternative are presented with their significance levels. In the second two columns, the effects of the context variables on the car are shown and in the last two columns the difference of the effects of context variables on P&R and car are presented.

The table shows firstly that car drivers with heavy luggage are more likely to use both P&R and the car than car drivers without luggage. When comparing P&R with car, it is observed that the car alternative increases in a significantly larger degree in case of heavy luggage than the P&R alternative. These results could be explained by the fact that car drivers prefer to use the car for (a part of) the trip when they have to carry the heavy luggage. Moreover, car drivers traveling for work are less likely to use P&R and the car than car drivers traveling for recreational purposes. This might be explained by the fact that people are less likely to use a P&R facility every day than to use the P&R incidentally. No significant differences appear when comparing the P&R with the car for travel purposes. Furthermore, car drivers without a passenger are more likely to use both the P&R and the car than car drivers with one passenger. This reflects the notion that one feels more convenient when using public transport if one is not alone. In addition, only the influence of weather on P&R is significant. The P&R will be more attractive when the weather is bad. Further, the P&R is preferred better than the car in case of bad weather. This may reflect that under such conditions, congestion in and around cities may be worse. Finally, considering the influence of the moment of the day, both the influence on the P&R and the car is not significant, albeit different for men and women. Additional analysis shows that women do not prefer to travel by public transport in the evening hours relative to men. Comparing P&R with car delivers no significance difference.

Overall, it can be concluded that the importance scores do not diverge that much between the attributes; all attributes, including those being considered in the choice model, substantially contribute to the choice behavior of the traveler. When considering the influence of context variables against the influence of the attributes describing costs, times and quality of P&R and Public Transport, the context variables seem to have a smaller influence. However, the influence of travel purpose on P&R and car and the influence of luggage on the car are larger.

4 CONCLUSIONS

In this paper the car drivers' preferences for P&R facilities were traced by applying the HII approach. A stated preference model was measured for both 'quality of P&R facilities' and 'quality of additional public transport'. These models were then integrated into the choice model, with the part-worth utilities required to estimate the percentages of use of P&R, car and public transport. In addition, the effects of context variables weather, luggage, passengers, travel purpose and time of the day on decision-making were estimated. All estimated part-worth utilities were in directions as expected and the goodness-of-fit indices indicated high model fit. This gives confidence in the estimated model and also in the application of the HII approach to model mode choice.

The results of applying the HII method, first of all, show that much attention should be paid to safety aspects, such as supervision by cameras and a safe pedestrian route. Additional provisions, for example a heated waiting room or a supermarket are less important in respondents' evaluation for the quality of a P&R facility. The success of a P&R facility also is influenced by the quality of additional public transport connecting the P&R with the destination of the traveler. The results show that the certainty of a seat was the most important attribute in the decision construct 'quality of additional public transport'. This being the most important PT quality attribute, the seat availability should be taken into account very well while planning the PT transport from P&R facilities. For example, one should be very careful in planning an additional stop at the P&R facility or diverting existing regional bus or train services, because those vehicles can already be rather crowded when they arrive on the outskirts of the city. As an alternative, separate shuttles from P&R to the city center should be considered.

The part-worth utilities of the attributes in the choice model show that the car driver is more willing to use P&R if the extra travel time or extra costs related to car use is high. Matched with actual developments, this indicates that in the future an increasing number of drivers will more regularly use P&R facilities because inbound congestion is still getting worse in many cities. Some cities, for example London and Rome, consider toll systems for entering the city. Moreover, inner cities increasingly introduce restricting parking policies, either putting a hold on building new parking facilities or by increasing parking fees. Such policies cause more time to find cheap parking lots and more time to walk to the final destination. These measures will make it increasingly unattractive to enter inner cities by car and, hence, will stimulate drivers to use alternative transport modes, including P&R.

The willingness of car drivers to use P&R also increases if the extra travel time when using P&R is low. Offering high-speed additional public transport realized for example by a free (bus) lane to the city and enabling efficient transferring at P&R could realize this low extra travel time. The results of the analyses indicate that type of transport is not relevant in this context. Moreover, the extra costs of P&R such as parking costs at P&R and costs of the additional public transport should be kept relatively low.

When comparing the influence of context variables with the influence of the attributes describing costs, times, quality of P&R and quality of public transport, the context variables seem to have a smaller influence. However, some relevant recommendations can be derived from the effect of context variables on decision-making. For instance, historic cities often attract many visitors, who visit the city infrequently for recreational purposes. According to our findings, these visitors are relatively willing to use P&R. The same holds true for visitors of special events or certain attraction points. The design and 'selling' of P&R facilities could therefore focus on these target groups.

Although there seem to exist possibilities to improve the success of P&R facilities to such specific target groups, it remains important to alleviate day-to-day traffic management problems to stimulate commuters to use these facilities. We have argued that the success of such facilities depends on the extent to which policy makers and marketing have been successful in meeting user preferences. The results of this study have identified the most critical attributes in this regard. It shows that the success of P&R facilities ultimately depends on integral policies that not only improve the quality of the P&R facility as such but also improve the quality of the full multi-modal chain and discourage the use of the car into the city center. It would be interesting to analyze whether P&R facilities designed in terms of such an integral policy perspective indeed perform better than the first generation of P&R facilities, which were typically developed from a "we build it and they will come" perspective.

REFERENCES

[1] Heijden, R.E.C.M. van der, E.J.E. Molin, D.M. Bos (2000), Parking at a distance: option for reducing traffic and parking pressure in urban areas?. *In: Urban Transport and the Environment for the 21st century.* Urban Transport VI, Witpress Boston, Southampton, p. 145-177.

[2] Ministry of Transport, Public Works and Water Management (2000*), Transferia: een handreiking bij voorbereiding en realisatie*, Den Haag (in Dutch).

[3] Muconsult (2000)*, Evaluatie transferia (Module I)*, Amersfoort, (in Dutch)

[4] Heijden, R.E.C.M. van der, E.J.E. Molin (2002), Locating P&R facilities based on travel behavior: a Dutch case study. In: *Urban Transport and the Environment in the 21st century.* Urban Transport VIII, Witpress Boston, Southampton, p. 733-742.

[5] Lo, H.P., and Lam, W. (2000), A Latent Class Model Applied to Stated Preference Data, *Ninth International Conference on Travel Behavior Research*, Goldcoast, Queensland.

[6] Guan, H.Z. and K. Nishii (2000), A modeling method for estimating the P&BR demand, *2nd International Conference on Traffic and Transportation Studies (ICTTS 2000)*, No jiaotong University, Beijing, Peoples R. China, July 31-August 02, 2000.

[7] Ghali, M.O., M. Pursula, D. Milne, M. Keranen, M. Daleno and M. Vougiokas (1997), Assessing the impact of integrated trans modal urban transport pricing on modal split, Transportation Planning methods Volume 1. *Proceedings of Seminar E held at PTRC European Transport Forum*, Brunel University, England, 1-5 September 1997. Volume P414. 1997/09. p. 341-352.

[8] Waerden, P. van der, A. Borgers en E. van Schaijk (1997), Parkeergelegenheden met overstapfaciliteiten in het stedelijk verkeer, *Colloquium Vervoersplanologisch Speurwerk 1997. Sprong in het duister? Lange termijn ontwikkelingen in het vervoersplanologisch onderzoek.* Amsterdam, 27-28 November 1997. Part III. 1997. p. 1523-1540 (in Dutch).

[9] Bradley, M.A., E. Kroes and E. Hinloopen (1993), A joint model of mode/parking type choice with supply-constrained application, Transportation planning methods. *Proceedings of seminar D held at the PTRC European Transport.* Highways and Planning 21st Summer Annual Meeting (September 13-17, 1993), Umist. Volume P363. 1993. p. 61-73.

[10] Polydoropoulou-A; Ben-Akiva-M (2001), Combined revealed and stated preference nested logit access and mode choice model for multiple mass transit technologies, *Transportation Research Record.* 2001. (1771) p. 38-45

[11] Louviere, J.J. (1984), 'Hierarchical information integration: a new method for the design and analysis of complex multiattribute judgement problems' in *Advances in Consumer Research*, Volume XI Ed. Th. C. Kinnear, p. 148-155.

[12] Louviere, J.J., G.J. Gaeth (1987), 'Decomposing the Determinants of Supermarket Choice: A Hierarchical Information Integration Approach', *Journal of Retailing*, 63 (1), p. 25-48.

[13] Louviere, J.J., H.J.P. Timmermans (1990), 'Using hierarchical information integration to model consumer responses to possible planning actions: recreation destination choice illustration' *Environment and Planning A* 22, p. 291-308.

[14] Molin, E.J.E. (1999), *Conjoint modeling approaches for residential group preferences*. Dissertation, Eindhoven University of Technology.

[15] Molin, E.J.E., H. Oppewal and Timmermans, H.J.P. (2003), Conjoint modeling of residential group preferences: a comparison of hierarchical information integration approaches, *Journal of Geographical Systems*, 14, 343-358.

[16] Norojono, O. and W. Young (2000), A stated preference freight mode choice model, *Ninth International Conference on Travel Behavior Research*, Goldcoast, Queensland.

[17] Louviere, J.J., H.J.P. Timmermans (1992), 'Testing the external validity of hierarchical conjoint analysis models of recreational destination choice' *In Leisure Science*, vol. 14. Taylor and Francis, UK.

[18] Bos, D.M., E.J.E. Molin, R.E.C.M. van der Heijden (2002), User-based definition of higher-order decision constructs to model preferences for P&R transfer points. *In: Urban Transport and the Environment in the 21st century.* Urban Transport VIII, Witpress Boston, Southampton, p. 417-426.

[19] Bos, D.M., E.J.E. Molin, H.J.P. Timmermans and R.E.C.M. van der Heijden (2003), Cognitions and Relative Importances Underlying Consumer Valuation of Park and Ride Facilities. *In: Proceedings of the 82th Annual Meeting of the Transport Research Board.* 82st Annual Meeting of the Transport Research Board (Washington D.C., 12-16 januari 2003).

[20] Timmermans, H.J.P. (1989), Een decompositioneel hierarchisch model voor woningkeuze: theorie en illustratie. In J. Musterd (ed.): *Methoden voor Woning en Woonmilieubehoefte Onderzoek SISWO*, Amsterdam, pp. 46-72.

List of tables and figures

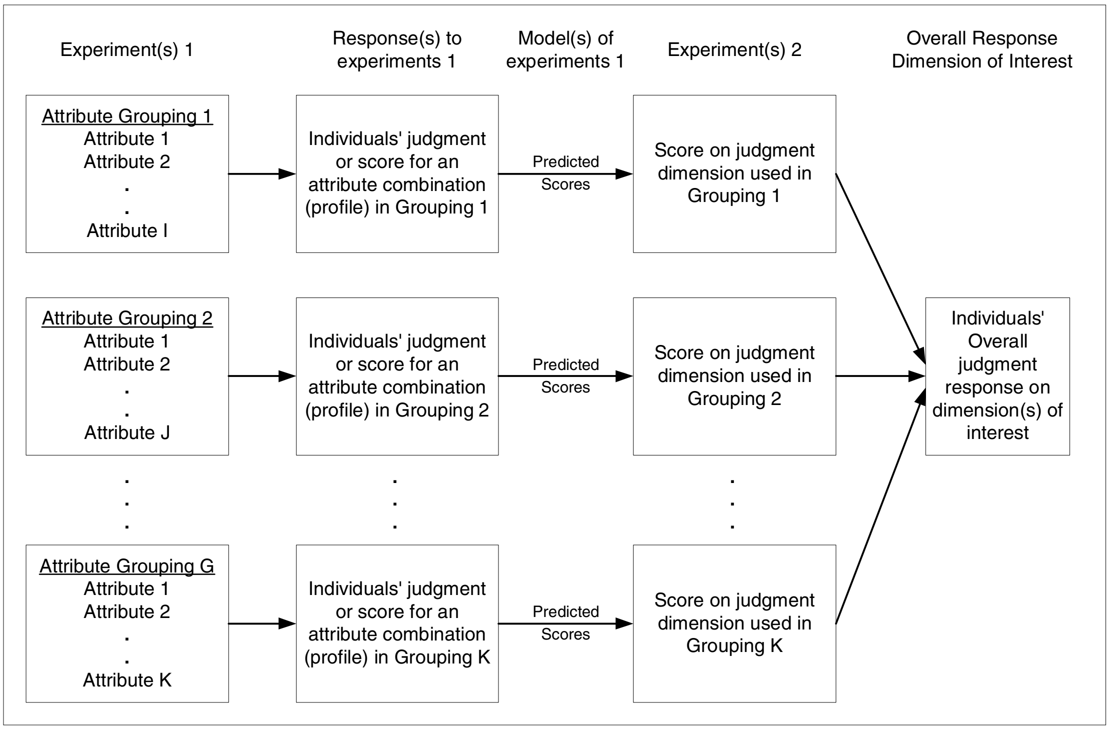

FIGURE 1 Flowchart of proposed hierarchical judgment process (Source: Louviere, 1984)

TABLE 1 Response group characteristics

	Absolute (N=734)	*Relative (100%)*
1 Sex		
Male	439	54.5
Female	356	44.2
Missing values	10	1.2
2 Education level		
Bachelor's/master's degree	445	55.3
Lower or intermediate education	351	43.6
Missing values	9	1.1
3 Age		
18-30	154	19.1
31-50	448	55.7
51+	166	20.6
Missing values	37	4.6
4 Class of car		
City car / compact class	253	31.4
(Compact) middle class	439	54.5
Highly middle class / Top class / Others	101	12.5
Missing values	12	1.5
5 Ownership of car		
Own car	730	90.7
Lease car	66	8.2
Missing values	9	1.1
6 Experience with P&Rs		
Experience	285	35.4
No experience (rarely or never used)	503	62.5
Missing values	17	2.1
7 Experience with PT in general		
Experience	567	70.4
No experience (rarely or never used)	232	28.8
Missing values	6	0.7

TABLE 2 Part-worth utilities quality of P&R facilities (N=800)

Attributes	*P-w utility*	*Sign. level*	*Importance (rank order)*
Overall utility (intercept)	4.99	0.00	
1 Supervision			23.6 (1)
No supervision	-0,75	0.00	
Cameras	0,21	0.02	
Cameras and supervisors	0,54		
2 Maintenance			19.3 (2)
Clean, good state of repair	0,66	0.00	
Holes in asphalt	-0,26	0.01	
Graffiti and holes in asphalt	-0,40		
3 Pedestrian route car - PT			17.2 (3)
Obscure and abandoned	-0,48	0.00	
Surveyable but abandoned	0,03	0.61	
Surveyable and lively	0,46		
4 Additional provisions			12.2 (4)
No additional provisions	-0,32	0.01	
Kiosk	-0,04	0.50	
Supermarket	0,35		
5 Walking time car - PT			12.0 (5)
1 min	0,28	0.01	
3 min	0,10	0.15	
5 min	-0,38		
6 Waiting room			11.8 (6)
No waiting room	-0,34	0.01	
Covered but unheated	0,03	0.63	
Covered and heated	0,31		
7 Paying facilities			3.9 (7)
Paying machine	0,11	0.12	
Manned ticket service	0,00	0.96	
Electronic with a chip card	-0,11		
R^2 = 0.996			

TABLE 3 Part-worth utilities quality of additional public transport (N=758)

Attributes	*P-w utility*	*Importance (rank order)*
Overall utility (intercept)	5.36	
1 Certainty of seat		42.1 (1)
5% chance	-1.04	
50% chance	0.11	
95% chance	0.93	
2 Number of transfers		33.1 (2)
0 transfers	0.77	
1 guaranteed transfer	-0.00	
1 not guaranteed transfer	-0.77	
3 Frequency of PT		21.1 (3)
Once in 5 min	0.44	
Once in 10 min	0.11	
Once in 15 min	-0.55	
4 PT Mode		3.6 (4)
Metro / Train	0.04	
Tram / LightRail	0.08	
Bus	-0.13	

TABLE 4 Part-worth utilities of attributes in the choice model (N=708)

Attributes	*Part worth utility*	*Sign. Level*	*Importance (rank order)*
Intercept P&R	0.52	0.00	
1 Extra time using P&R			**15.8 (2)**
0 minutes	0.46	0.00	
10 minutes	0.15	0.00	
20 minutes	-0.61		
2 Extra costs using P&R			**15.1 (3)**
€ 0.--	0.49	0.00	
€ 2.--	0.05	0.14	
€ 4.--	-0.54		
3 Quality of P&R			**14.0 (5)**
Value 4	-0.48	0.00	
Value 6	0.02	0.61	
Value 8	0.47		
4 Quality of PT			**11.7 (6)**
Value 4	-0.39	0.00	
Value 6	-0.02	0.64	
Value 8	0.40		
Intercept car	1.31	0.00	
5 Extra time using car			**29.0 (1)**
0 minutes	1.00	0.00	
20 minutes	-0.04	0.15	
40 minutes	-0.96		
6 Extra costs using car			**14.5 (4)**
€ 0.50	0.48	0.00	
€ 3.50	0.02	0.00	
€ 6.50	-0.50		

TABLE 5 Part-worth utilities of the context variables in the choice model (N=708)

Context variables	On P&R		On car		Between P&R and car	
	Part worth utility	*Sign. level*	*Part worth utility*	*Sign. level*	*Part worth utility*	*Sign. level*
Luggage on P&R						
No luggage	-0.25	0.00	-0.39	0.00	0.06	0.00
Heavy luggage	0.25		0.39		-0.06	
Travel purpose on P&R						
Working	-0.32	0.00	-0.30	0.00	-0.00	0.95
Recreational purposes	0.32		0.30		0.00	
Passengers on P&R						
No passengers	0.07	0.02	0.18	0.00	-0.04	0.00
One passenger	-0.07		-0.18		0.04	
Weather on P&R						
Good weather	-0.08	0.00	-0.02	0.54	-0.04	0.00
Rainy weather	0.08		0.02		0.04	
Moment of day on P&R						
Traveling by day	-0.05	0.13	0.00	0.94	-0.02	0.11
Traveling in the evening	0.05		-0.00		0.02	