ANALYSIS OF TRAVELLERS' SATISFACTION ON TRANSPORT CHAINS

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May 1999

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Abstract

This paper focuses on the network character of a multimodal transport system in which interconnectivity is the key determinant of its performance, relative to unimodal transport opportunities. The emphasis is on the viability of chain mobility in public transport by analyzing the satisfaction of travellers on a transferpoint with respect to its accessibility, the parking facilities offered and the schedule coordination in the central node. The statistical analysis, based on individual, subjective responses on the performance of two Dutch railway stations, enables to identify the degree of satisfaction of various groups of travellers in regard to the performance of a multimodal network. This finding may prove to be useful for network operators who aim at a complementarity or cooperation with unimodal transport systems.

1. Interconnected Networks and Chain Mobility

Transportation networks have become the leading configurations for spatial economic interaction. Conventional choice processes in a transport network are usually dealt with in a straightforward analytical fashion by means of modal choice models, route choice models, departure time choice models and the like. In recent years these classes of models have been significantly extended by also including relevant trip information (for instance, on congested roads, on delays in public transport, on unfavourable weather conditions and so forth) as a main driving force or motive for trip choices or adjustments therein (a review is contained in Emmerink and Nijkamp 1999). The type of models has also witnessed a broad spectrum of analytical applications, ranging from spatial interaction models to discrete choice models. Especially the latter set of models has shown an increasing popularity as a result of the rapid rise in and availability of micro-based travel data, sometimes even on a longitudinal basis.

There is however one area of research which has received less attention in past research endeavours, viz. the network character of a transport system. Many trips are not made as single origin-destination trips, but require a complicated choice process in which different segments of a transport system, different transport modes and different transport times (or costs) are involved. Thus, an origin-destination trip comprises usually a rich choice spectrum of routes, modes and costs. Especially in a metropolitan area the number of combined trip characteristics is vast. This is caused by the complexity and multidimensionality of a modern transport network, in which **interconnectivity** – in both a geographical and a transport system's sense – plays a critical role (see also Button et al. 1998; Capineri and Rietveld 1998). This issue of interconnectivity is an important policy concern at all spatial levels ranging from local to international (witness also the debate on Trans-European Networks).

An important consequence of multi-faceted interconnected networks is the emergence of chain mobility. Trip-makers have to make complicated route, mode, time and cost choices in a chain of mobility options, which have to be of course integrated in one trip decision. Efficient trip behaviour (and hence information on the manifold aspects of all components of the chains) is not only desirable from an economic perspective, but also from an environmental perspective (see Verhoef 1996).

In practice, we observe a formidable variety in choice behaviour of trip-makers in a mobility chain, and therefore it is important to investigate more thoroughly the various underlying motives and perceptions (see e.g., Bovy and Stern, 1990 and Fischer, 1993). This requires field research based on micro information on the motives and behavioural patterns of travellers in a transport chain. The aim of the present paper is to investigate the behavioural backgrounds of the wide variation in trip behaviour of travellers in a complicated chain in which both public transport and private transport play a role, not only as competing modes but also as complementary modes. The empirical application will be concerned with a case study in the Gooi area east of Amsterdam. The paper will first address the research issues in this area, and will then produce some of the statistical data and results. It will finally use a discrete choice model to identify the relevance of various behavioural motives in making a chain choice. The paper will be concluded with some policy implications.

2. Transferpoints and Multimodal Transport of Persons

Nodal points are essential in a network. A particular type of nodal points is formed by transfer or interchange points. In general, a transfer point has three main functions that jointly determine its usability and efficiency. First, a transfer point has to connect the links (modes) in the transport system, second, it has to collect and distribute travellers, and third it has to concentrate travel flows to achieve economics of scale. To be competitive with unimodal transport (usually by car), a multimodal transfer point has to ensure that the travelling time from and to the transfer point (node) is minimized and also that interchanges take place as quickly as possible. A crucial factor in this respect is the accessibility of the transfer point (node): the capacity and the quality (through-flow intensity) of "feeding" and "backing" transport infrastructure will be critical success factors for the accessibility of the transfer point. Moreover, the schedule coordination between different modes linked to the transfer point has to be optimized in order to offer a multimodal trip that is as fast (and as cheap) as a unimodal trip by car (see e.g., Van Binsbergen and Bovy, 1996).

In order to minimize travel time (and thereby costs) in public transport chains, the scheduled travel times needs to be reliable. This reliability will heavily depend on the probability of missing the connection at interchanges (i.e., the schedule coordination). And reliability in general, and reliability at the point of interchange in particular will - on its turn - influence significantly the individual's choice between unimodel (car) transport versus multimodal (public) transport (see e.g., Baayens et al., 1997, and Bruinsma et al., 1998a). Reliability of public transport chains have to be studied differently from reliability of private transport modes in which the focus is on vehicle arrival times. In case of public transport chains the emphasis has to been on passenger arrival times (i.e., following a customer-oriented approach). Bruinsma et al. (1998a) have emphasized two major sources of unreliability in public transport. First, missing the subsequent connection at the transferpoint due to delays during the entry-trip, and second, long waiting times are deliberately scheduled at interchanges to anticipate the unreliability in the entry mode.

Moreover, it has been examined empirically in Bruinsma et al. (1998a) how unreliability affects travel behaviour in public transport by focusing on (the distribution of) departure and arrival times. In this way, travel time losses (costs) can be determined and thereby offering the opportunity to evaluate unreliability (see also e.g., Carey, 1994). In particular, Bruinsma et al. (1998a) have analyzed the departure and arrival time deviations by comparing scheduled and realized departure and arrival times for the most commonly used public transport chains in the Netherlands (like bus/bus-bus/bus-train etc). It is found that "irrespective of the period of the day, there is an expected delay of travel time of about 10% compared to the official scheduled travel time. Bruinsma et al. (1998a) have also put forward that delays are (i) increasing with distance and the number of transfers, (ii) usually related to the basic frequencies of public transport services, that additional travel time most often implies additional waiting time at interchanges and that - for all modes considered - departure takes place sometimes too early.

These estimates of unreliability may - when combined with an evaluation of travel time (i.e, the willingness to pay) - prove to be useful for the design of realibility enhancing strategies by public transport service providers. In a follow-up study of Bruinsma et al. (1998b) several options - in which improvements are assumed to take place in transfer time, frequency of service or reliability of departure time - are investigated with respect to their effects on in-vehicle travel time, waiting time, and unreliability. The most promising instrument appeared to originate from an intensified use of the bicycle as entrance and/or exit mode, since this leads to significant ameliorations in waiting time and unreliability (deviation from schedule travel times). Moreover, it is shown (see also Bruinsma et al., 1998b) by computing generalised travel costs for each option that the best (most rewarding) policy for the average passenger is also to increase the use of the bicycle for the entrance and/or exit mode. Other favourable options appeared to be an increase in transfer time and the avoidance of busses leaving too early. It is also noteworthy that passengers revealed a substantial dislike for unreliable services that lead to delays (ar risk-averse attitude towards travel time). According to Bruinsma et al. (1998b) this implies that "a likely acceptance of an increase in public transport tariffs if reliability is improved".

To sum up, the empirical findings discussed above show that promising and economically profitable investments in public transport facilities can be made by the provision of better facilities (parking stands for bikes and taking measures that prevent bike theft), the by-passing of miss connections at interchanges (increase transfer time), and avoiding the early departure of buses. More broadly, it has been concluded from the studies on (un)-reliability that improvements in the multimodal transferpoint's performance can be beneficiary for the revenues of public transport companies and - at the same time - yield an increased market share of public transport.

In general, the performance of a multimodal transferpoint is affected by

(1) the accessibility of the transferpoint,
(2) the facilities of the transfer point (in particular parking),
(3) the schedule coordination in the transfer point.

The importance of local accessibility of a railway station has recently been stressed (see Keyer and Rietveld 1999), since an improvement in accessibility appears to lead in general to a higher railway use. And related to this, a similar relationship holds for an amelioration in the parking facilities of the transfer point (i.e., railway station). The relevance of schedule coordination in the transfer point lies in the reduction of the waiting time at the transfer point. thereby making multimodal transport trips more attractive (relative to unimodal trips). Of course, uncertainty due to an interchange at a transfer point can never be completely eliminated, but a decrease in the expected waiting time will give rise to lower opportunity costs of the loss of comfort (due to an interchange) in case of a multimodal trip.

In the present paper, the focus is on the functioning of chain mobility in public transport and in particular on the trip from home to the transfer point (railway station). The question then arises how one should actually measure this performance of a transfer point in a transit system. Basically, two approaches are possible.

First, an analysis of *modal choice* may be carried out in which use is made of either revealed or stated preferences of the travellers. Revealed preferences are based on what kind of mode the traveller *did* choose when making a trip, while stated preferences rely on traveller's statements about what kind of mode they *would* select when making a trip. Both types of preferences can be exploited to analyse statistically the decision to use a given mode. The usual way to do so is to estimate discrete choice models of modal choice. Of particular interest is the choice between multimodal (most often public, e.g., bus-train-walk) versus unimodal (usually private e.g., car) transport. From a methodological point of view, it is noteworthy that this type of discrete choice model can be regarded as a comparison of the utility of using a mode, with the aim to choose the one with the highest outcome (see for an outstanding exposition e,g., Small, 1992). The key factors that determine the modal choice are - among other things - travel time, price, reliability and comfort (see also Small, 1992). It can be argued that multimodal transport chains are more used in longer trips (see e.g., Keyer and Rietveld, 1999), whereas unimodal transport (by car) is more likely to be used for short trips. Moreover, multimodal trips may - on the one hand - be cheaper and faster than unimodal trips (and for "captives" it is the only option available), but may on the other hand be suffering from problems like (i) detours and (ii) waiting and rescheduling time (see also Keyer and Rietveld, 1999).

A second, fully subjective, approach is to employ the *(potential) traveller's opinions on the functioning of the transfer point* (railway station) to analyse its competiveness. The fundamental question to be asked then is how the traveller evaluates the key aspects (services and facilities) of the transferpoint. In this paper we will follow this research line, and hence the investigation concentrates on the degree of satisfaction on the factors outlined above:

(1) the accessibility of the transfer point,
(2) the parking facilities of the transfer point,
(3) the schedule coordination in the transfer point.

In this paper, the focus will be on a specific transport chain in which the central node is formed by a public transport terminal (i.e., a railway station) that can be reached by both public (e.g., bus) modes and private modes (e.g., walking, bicycle or car). The next section will set out the performance, as perceived by the users, of two Dutch railway stations, both located on one of the main corridors to the city of Amsterdam (corridor Het Gooi area - Amsterdam agglomeration).

3. Description of the Case Study

Travelling by public transport is almost always a chain of movements, because transport to and from a public transport terminal is necessary. With the help of a survey questionnaire, an attempt has been made to investigate the transport chain of train passengers in the Dutch area Het Gooi (east of Amsterdam). The questionnaire was distributed among passengers travelling via the railway stations Naarden-Bussum or Bussum Zuid in Het Gooi into the direction of Amsterdam. Notice that the questionnaires were handed over to the passengers at the entrance of the railway station, and requested to send the filled form at a later (convenient) moment. The corridor between Het Gooi and Amsterdam was chosen for this study, because it is one of the most important transport corridors of the northern part of the Randstad in the Netherlands.

Before presenting the results of our survey, we will first briefly describe the parking facilities on the railway stations Naarden-Bussum and Bussum Zuid. Station Naarden-Bussum has a guarded bicycle store, where it is also possible to hire a bike. Bussum Zuid has no guarded cycle store, but at this station, bicycle lockers are available.

Bussum Zuid is a Park and Ride station (P&R-station), which means that there is a large number of parking places for cars. Around the much bigger railway station Naarden-Bussum, there are not enough parking places for cars, hence it is almost impossible to park a car close to the station. Naarden-Bussum and Bussum Zuid are both attainable by bus, but the bus facilities to Naarden-Bussum are better.

Naarden-Bussum has a frequency of four trains an hour with destination Amsterdam Central Station (CS) or Amsterdam Airport Schiphol. Two of them are all station trains and two are fast trains. From station Bussum Zuid two trains leave every hour to Amsterdam CS and Schiphol. These are both all station trains. To make Amsterdam CS and Schiphol more frequent attainable, the trains from the so-called Gooilijn (from Het Gooi to Amsterdam) and the Flevolijn (from Lelystad and Almere to Amsterdam) wait for each other at station Weesp, so that a better interconnection is offered. This idea however, is not working ideally because of delays for fast trains from Het Gooi thereby leading to miss connections at station Weesp and to long waiting times for all station trains at station Weesp.

To identify bottlenecks in the behaviour of passengers and to investigate their motives in a multi-mode trip, a survey questionnaire has been used. This survey was part of a market investigation into transport chains of passengers. The questionnaires were distributed in December 1997 and January 1998 during cold but dry weather. At station Naarden-Bussum, the questionnaires were distributed from 7.30 AM till 3.30 PM, while at station Bussum Zuid they are distributed between 7.30 AM and 9.30 AM. After 9.30 AM, this station is not much used by passengers in the direction of Amsterdam. Some details on the survey are given below.

- *Naarden-Bussum:* 405 questionnaires were distributed with a response of 217 (54 %). Because some passengers use different transport modes on different days to the station, a total database of 266 chains was generated.
- *Bussum Zuid:* 59 questionnaires were distributed with a response of 36 (61 %). Because some passengers use different transport modes on different days to the station, a total database of 47 chains was generated.
- *Total:* 464 questionnaires were distributed with a response of 253 (55 %). Because some passengers use different entry modes on different days, a total database of 313 chains was generated. The high response rate can be explained by the broadly perceived low quality of the travel product of the Dutch Railways (NS) on this line. Many travellers used the questionnaire to express their complaints (a protest sign).

4. Description of the Statistical Results

We will now briefly describe some statistical results on the above mentioned segments of the Dutch railway system.

4.1 Modes of transport to the railway station

The passengers between the stations in Het Gooi and Amsterdam can be distinguished by their entry mode to the stations Naarden Bussum and Bussum Zuid (see Table 1). The transport to Naarden Bussum happens mostly by bike (34%) and to Bussum Zuid by foot (40%). Although the parking facility at the station Bussum Zuid is much better, the percentage of travellers that go by car to this station is only 7 % higher than that at Naarden-Bussum. The bus is remarkably little used as an entry mode to the station Bussum Zuid (9%). The total modal split of these two stations is almost the same as the average modal split of modes of transport to Dutch railway stations (see Keyer and Rietveld , 1999).

Table 1: Modal split of trips to the station

	Naarden-Bussum		*Bussum Zuid*		*Total*	
Walking	73	27%	19	40%	92	29%
Cycle	91	34%	15	32%	106	34%
Car	33	12%	9	19%	42	13%
Bus	69	26%	4	9%	73	23%
Total	**266**	**100%**	**47**	**100%**	**313**	**100%**

4.2 Origins of the passengers

The passengers were asked for the postal code of their home to get a better view on the variability in the mobility chains of the passengers. The station Naarden-Bussum appears to have a regional function for the whole northern part of Het Gooi. The passengers on that station are not only living in Naarden or Bussum, but also in surrounding villages like Huizen, Hilversumse Meent en Blaricum. The passengers from the southern part of Het Gooi are mostly oriented towards the stations in Hilversum.

The passengers, who travel via the station Bussum Zuid, originate almost all from Bussum (91%). As Bussum Zuid is a P&R-station, it should have a regional function, but in fact it is not. This is conceivable, because fast trains do not stop at Bussum Zuid. Two trains an hour is apparently not attractive enough to take the train for a part of the trip.

4.3 Availability of a car

The travellers who use public transport can be subdivided into public transport captives (travellers who do not have the availability of a car) and 'choice travellers' (travellers who do have the availability of a car). The use of entry modes to the station is clearly different for public transport captives compared to choice travellers (see Figure 2). 34% of the choice travellers use a car to travel to the station, while only 3% of the public transport captives go to the station by car. The percentage of travellers that go by bike or foot to the station is a little bit lower for choice travellers than for public transport captives. But the percentage of travellers that use the bus as a mode of transport to the station is much smaller for choice travellers than for public transport captives. This means that choice travellers, who do not live on a walking or cycling distance from the station, prefer to use the car for their whole trip. So the bus-train chain is no good alternative for the car.

Figure 1 about here

4.4 Desired improvements in the mobility chain

In the survey, the passengers were asked for necessary improvements, in order to make them go (more often) with a certain entry mode. Table 2 shows the percentage of passengers at Naarden-Bussum and at Bussum Zuid for whom certain improvements are necessary.

At both railway stations, the passengers prefer improvements that make the travel time shorter to improvements for more comfortable facilities. Examples of improvements that make the travel time shorter are a better connection between bus and train, more frequent buses, lower parking search time because of better parking facilities for cars and a shorter bus trip. Only better parking facilities for bikes do not improve the travel time, but they are also necessary according to the passengers.

Table 2: Percentage of desired improvements on stations Naarden-Bussum and Bussum Zuid

		Total (NB)	*Total (BZ)*
I would go (more often) with the bus to the station if:			
	The connection of the timetables of bus and train would be better.	**39%**	**47%**
	The bus trip would take less long.	**24%**	**15%**
	The buses would drive more frequent.	**42%**	**32%**
	There would always be a place to sit in the bus.	**16%**	**4%**
	There would be bicycle stands at the bus stop.	**11%**	**2%**
	There would be a comfortable waiting room at the bus stop.	**20%**	**13%**
I would go (more often) by car to the station if:			
	The station would be better accessible by car.	**17%**	**6%**
	There would be better possibilities to park a car near the station.	**30%**	**6%**
I would go (more often) by bike to the station if:			
	The station would be better attainable by bike.	**12%**	**13%**
	There would be enough cycle stands near the station.	**38%**	**17%**
	The guarded cycle store would be cheaper.	**40%**	**..**
	The bicycle lockers would be cheaper.	**..**	**38%**
	The bike could be parked closer to the platform.	**13%**	**13%**

4.5 Travel time between Het Gooi and Amsterdam

It is clear that the competing power of public transport is mainly depending on the travel time. Based on the results of the survey questionnaire, the average travel time is computed for the different entry modes.

Table 3: Average transport time to the station (in minutes)

	Naarden-Bussum	*Bussum Zuid*
Walking	**11½**	**12**
Cycle	**13½**	**10**
Car	**17½**	**15½**
Bus	**30½**	**29**

In Figure 2 the transport time to the stations Naarden-Bussum and Bussum Zuid is compared to average transport time to Dutch stations.

Figure 2 about here

Remarkable is the entry time by foot to Bussum Zuid and Naarden-Bussum, which is lower than average. The main reason is the high density of the area around the stations in Het Gooi, especially around Naarden-Bussum. The entry time by car is at station Naarden-

Bussum higher than average. This is probably caused by the search time for parking, which is high at Naarden-Bussum because of the lack of parking places.

The entry time by bus is at the two stations in Het Gooi - and at the Dutch stations in general - much higher than that of the other modes of transport. This is because the entry time by bus is not only the in-vehicle time, but also the transport time to the bus stop and the transfer (waiting) time between bus and train at the railway station.

Figure 2

Unfortunately, the actual travel time rises often because of delays of the trains between Het Gooi - Amsterdam. Because of the tight connection of the fast trains at station Weesp, a small delay of the fast train makes the travel time between Het Gooi and Amsterdam easily rise with half an hour. And since the fast trains to Amsterdam have quite often a delay, the train is much less competitive. Without these delays however, the train would be a much stronger alternative for the car during rush hours.

4.6 Satisfaction

The performance of the multi-modal transfer points Naarden-Bussum and Bussum Zuid is affected by the accessibility of the transfer points, the (parking) facility of the transfer points and the schedule co-ordination in the transfer points. With the survey results, we present the percentage of dissatisfaction about the performance of a railway station in Table 4.

Table 4: percentage of dissatisfaction

Performance	***BAD***
Accessibility by foot	21%
Accessibility by bike	13%
(parking) facilities for a bike	35%
Accessibility by car	29%
(parking) facilities for a car	37%
Schedule co-ordination between bus and train	64%

In the next section, these percentages of (dis)satisfaction are explained by characteristics of passengers in a statistical analysis.

5. A Statistical Analysis of the Functioning of Chain Mobility

In this section, the functioning of the Dutch transport corridor "Het Gooi- Amsterdam" is further investigated by using statistical findings from subjective responses to the performance of the multimodal transferpoint (railway station) of travelling passengers (as reported in the survey questionnaire, see Section 3). It is noteworthy to mention here that the focus of this analysis will be on actual users and not on potential users of public transport. Obviously, this means that the findings apply to this group of users only. This should be kept in mind since it is, for example, found that non-users perceive the reliability of public transport as less favourable than regular users (see Rooijers, 1998). A possible reason for this is that the non-users are disappointed travellers in the past.

In our empirical application we analyse the functioning of the transfer point in between the entry trip (that is, going from home to the node) and the transit trip (that is, going from node 1 to node 2). To be more specific, our survey provides information on the trip from the home-end to the railway station and the subsequent rail trip (and thus not on the trip from the destination railway station (second node) to the activity-end). Next, a statistical model is to be used in order to explain the degree of satisfaction on the three key factors mentioned above (accessibility, parking facilities, and schedule coordination). The accessibility of the railway station will clearly depend on the mode used in the pre-transit trip: in the analysis a distinction is made by using foot, bike or car as an entry mode. Especially of interest in the Dutch case is the use of the bicycle, given the high share of this entry mode (see also Table 1). As was revealed in Table 3, the choice of the entry mode depends strongly on the travel time (distance) to the railway station: on short distances travelling by foot or bicycle is preferred, on a long distance travellers tend to take the bus (and the use of the car takes a intermediate position here). Similarly, it will be taken into account that parking facilities are also mode-specific (that is, related to a bike or car used as an entry mode). And finally, the evaluation of the schedule coordination in the railway station will be based on the performance in chain mobility due to a modal switch in the node. In other words, it depends on the matching of the entry and the transit trip; in our analysis the bus-train connection will be examined.

The degree of satisfaction on the multimodal performance in terms of accessibility, parking facilities and schedule coordination are to be explained by individual-specific travel characteristics (as observed in the survey). We have data on the following travel characteristics (X):

- travel behaviour (frequency per week)
- travel motive (work/leisure/school/visit/others)
- travel time in entry trip
- travel assets (car owner or not)

This set of variables leaves out other individual-specific travel characteristics - that are not observed in the survey - such as preference for comfort ("taste"), income, education or attitude towards public transport. The net effect of this will be allowed for in our model by including a random error term (u).

The dependent variable (measuring the degree of satisfaction) in the statistical model has a binary (discrete) nature, since it is reported in the survey to be satisfied or not to be satisfied (a dummy variable: yes/no) with the features of the railway station mentioned above. Hence, the appropriate method to be used is to estimate a probability (logit) model (see e.g., Maddala, 1983). In this method it is assumed that there is an underlying response variable y^* defined by the regression relationship

$y^* = X'ß + u$,

where u is an random error term, and ß the vector of parameters to be estimated. X is a vector of observations on travel characteristics.

In practice, y^* is unobservable. What is observable is whether or not respondents are satisfied (noted as y=1 or 0, respectively). Now we define a relationship between the observed and latent (unobserved) variables y and y^* as follows:

$y=1$, if $y^* > 0$

$y=0$, otherwise

on the basis of this assumption we get:

$Prob(y=1) = Prob\ (u < - X'ß)= 1-F(-X'ß)$,

where F is the cumulative distribution function of u (assumed to be logistic here).

This leads to the estimation of the following model (see equation 1) in which the probability (P) to be satisfied with the accessibility, parking facilities and schedule coordination is explained by the set of travel characteristics (X).

$$Prob(y_i=1) = Prob\ (y_i^* > 0) = Prob\ (u < - X'ß_i),\ \ i=1,...,6 \qquad (1)$$

with

y_1 = satisfaction on accessibility by foot

y_2 = satisfaction on accessibility by bicycle

y_3 = satisfaction on accessibility by car

y_4 = satisfaction on parking facilities for bicycles

y_5 = satisfaction on parking facilities for cars

y_6 = satisfaction on the schedule coordination (bus-train)

while the X-vector comprises the variables travel time, car ownership, travel frequency, and travel motive. Descriptive statistics of these explanatory variables are shown in Appendix A (besides travel time, see Table 3).

The estimation results of the logit model are presented in Table 5.

Table 5: Estimation results (p-values in brackets)

	Satisfaction	*Accessibility (by foot)*	*Accessibility (by bike)*	*Accessibility (by car)*	*Parking Facilities (bike)*	*Parking Facilities (car)*	*Schedule Coordination (bus-train)*
Constant		4.95* (0.00)	-21.94 (0.87)	1.06 (0.64)	2.79* (0.02)	19.71 (0.80)	-0.32 (0.84)
Travel Time		-0.11* (0.02)	-0.16* (0.01)	-0.11*** (0.12)	-0.01 (0.87)	-0.09 (0.25)	-0.10* (0.02)
Car Ownership		0.31 (0.69)	1.24 (0.22)	3.28* (0.05)	-0.53 (0.32)	-1.60 (0.30)	-2.09 (0.15)
Travel Frequency	Once a week	-0.72 (0.48)	9.46 (0.91)	0.96 (0.62)	-0.94 (0.17)	7.20 (0.89)	0.24 (0.81)
	Incidental	-1.63 (0.23)	12.66 (0.96)	-0.61 (-0.65)	0.20 (0.88)	-0.33 (0.82)	6.93* (0.00)
Travel Motive	Work	-1.65** (0.07)	25.42 (0.85)	-1.48 (0.28)	-1.66** (0.10)	-16.47 (0.83)	2.26** (0.10)
	Shopping	0.66 (0.59)	23.20 (0.91)	-0.52 (0.63)	-0.80 (0.46)	-15.20 (0.85)	0.05 (0.97)
	Education	-2.35* (0.02)	25.87 (0.85)	0.75 (0.69)	-1.77** (0.08)	-16.17 (0.84)	2.33*** (0.12)
	Visit	0.95 (0.41)	24.23 (0.86)	-1.24 (0.50)	-0.31 (0.72)	-9.62 (0.86)	0.87 (0.55)
	Others	-1.33 (0.32)	6.94 (0.92)	0.49 (0.75)	-1.12 (0.35)	-1.23 (0.46)	-0.79 (0.64)
Number of Observations		86	100	40	101	40	70
Pseudo R^2 (Nagelkerke)		0.195	0.329	0.338	0.106	0.508	0.385
Percentage of correctly predicted		82.6%	89.0%	75.0%	70.3%	77.5%	77.1%

* Significant at 5%.

** Significant at 10%

*** Significant at 12%

We will now subsequently discuss the main statistical findings of the satisfaction on the three core features (accessibility, parking facilities and schedule coordination) of the railway stations envisaged. Before doing so, it is noteworthy that more extensively specified models have been estimated also (including cross-product terms of travel motives with travel time or travel frequency, and a dummy variable for the railway station), but this did not lead to a significant improvement of the model.

To start with the satisfaction on accessibility by foot, we see that travel time has a significant negative impact, indicating that those travellers coming from longer distances are less content than those living nearby the railway station. Obviously, the chance to face certain inconveniences when making the trip is higher with the trip length. In addition to that, one can also think of a psychological, negative effect of longer trips on satisfaction because the perceived effort to get to the station is higher which may make people more critical. The motive for the walking trip also affects the satisfaction level. People who go to the train for work and school are less satisfied than others. This seems to be related to the compulsory nature of activities such as school and work and the importance of arriving there on time. In other words, the value of travel time is higher for commuting trips than for leisure trips and consequently, commuters are likely to be more critical towards the accessibility of the railway station.

As regards accessibility by bicycle, it is also found that for people who take their bicycle to get to the railway station, travel time has a significant negative effect on the satisfaction level. Presumably for the same reasons as argued for those traveling by foot.

And again in case of using the car, travel time influences significantly the satisfaction of accessibility in a negative way. For car travellers to the station, it is interesting to see that having a car has a strong positive effect on being pleased with the station's accessibility (as compared with those who do not own a car). This seems understandable due to the dependence of non car-owners on others to travel by car and the associated efforts to arrange such a (mutual) trip which could make people more critical towards the perceived accessibility.

To conclude on the accessibility evaluation, it appears that - irrespective of the mode used - the higher the travel time, the lower the satisfaction level.

When we consider the results with respect to the parking facilities of the railway station, it is seen for bicycle stands that people who go to work or school are significantly less pleased with these facilities than others. As argued before, this finding is likely to be due to the obligatory character of this kind of trip which would make people more critical (i.e., face a higher value of travel time) towards things like a lack of stands or the probability of theft.

Dissatisfaction among car-travellers on parking facilities at the railway station may arise when the parking capacity is insufficient and thereby leads to a long-lasting search time for a parking place. Somewhat surprisingly however, the estimation results show that none of the variables included have a significantly impact on the satisfaction level related to these parking facilities.

The final model analyses the determinants of being satisfied with the schedule coordination in the interchange between the bus (chosen as entry mode) and the train (to be used in transit trip). Obviously, travellers are likely to be less happy with interchanges that coincide with longer waiting times. Travel time by bus appears to affect the happiness of people significantly negative, indicating that the value of waiting time is higher for those who have faced a longer pre-transit trip. In addition, people with a frequent travel behaviour are less pleased with schedule coordination than those who travel occasionally. The latter group is probably less familiar with travel conditions and takes less risk than regular travellers (by leaving earlier) to arrive in time at the railway station. As a consequence, an unexpected delay in the entry trip has less devastating effects on the interchange, and hence satisfaction will on average be higher. In contrast to the models on accessibility, we notice that people going to work or school are significantly happier than those who travel for other (non-mandatory) reasons. We conjecture that this result is due to the fact that commuting (for work and school) takes place during rush hours in which the frequency of public transport is much higher. This would make the occurrence of a long interchange (and an unpleased feeling) less likely to take place.

To sum up, the empirical analysis has brought forward new insight into *which* features of a multimodal transport (railway) network in the Netherlands deserve further attention to enhance performance (and thereby competitiveness with unimodal transport). Equally important is however that the results have indicated *what kind of travellers* appear to be more or less satisfied with the functioning of a multimodal network. For example, it is found that those who commute for work and school are less satisfied with parking facilities for bicycles and accessibility of the station by foot. This kind of evidence is vital for the operators of multimodal networks to establish improvements that are desired by various target groups of travellers.

Another remarkable finding is the robustness of the size of the impact of travel time on the happiness with respect to accessibility of the railway station, viz. *independent* of the entry mode used.

6. **Conclusions**

This paper has explored individual choice behaviour towards multimodal trips in order to analyse the importance of interconnectivity of a transport network and also to study the opportunities for intensified use of public transport in combination with other modes. Travelling by public transport usually implies a chain of movements and hence, the different transport systems linked to a transfer point have to be well connected to make passenger transport chain movement competitive with a movement by car.

The approach chosen in this paper has been to employ subjective responses of travelling passengers to the performance of a mulimodal transferpoint. In particular, a Dutch survey is held for two nodes (railway stations) in Het Gooi-Amsterdam corridor to identity bottlenecks and to examine the passenger's motives in a multi-mode trip. From an explorative inspection, it appeared - among other things - that passengers prefer improvements in travel time to improvements in network facilities.

A statistical analysis of the performance of the transferpoint has concentrated on differences in satisfaction of the transferpoint's performance with respect to accessibility, parking facilities and schedule coordination. The estimation of discrete choice models has revealed that the higher the travel time, the less satisfied travellers are and - strikingly - this result appeared to hold irrespective of the mode used in the trip from home to the railway station. As regards parking facilities, it was shown that people who go to work or school are significantly less pleased with facilities for bicycles than others. And finally, it can be concluded that persons with a frequent travel behaviour are less pleased with schedule coordination in the transferpoint than those who travel occasionally.

To summarize, it is found which features of a Dutch multimodal transport (railway) network deserve more attention to increase its performance and its competitiveness. Moreover, it is found what kind of travellers appear to be more or less satisfied with the performance of a multimodal network (railway station). This finding may prove to be of crucial importance for network operators who aim at a complementarity or cooperation with unimodal transport systems.

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Appendix A:

Description of explanatory variables (car ownership, travel frequencies, and travel motives)

Table A1: Car Ownership: absolute number and percentage of travellers who have a car

	Naarden-Bussum Railway Station		*Bussum Zuid Railway Station*		*Total*	
Walking	20	27%	5	26%	25	27%
Biclycle	24	26%	5	33%	29	27%
Car	28	85%	8	89%	36	86%
Bus	13	19%	0	0%	13	18%
Total	**85**	**32%**	**18**	**38%**	**103**	**33%**

Table A2: Travel Frequency: absolute number and percentage of travellers

	Naarden-Bussum Railway Station		*Bussum Zuid Railway Station*		*Total*	
Walking	8	11%	0	0%	8	9%
Bicylce	6	7%	0	0%	6	6%
Car	13	39%	3	33%	16	38%
Bus	8	12%	0	0%	8	11%
Total	**35**	**13%**	**3**	**6%**	**38**	**12%**

Table A3: Travel Motives

a) percentage of total trips to Naarden-Bussum Railway Station

	Work	*Shopping*	*Education*	*Visit*	*Others*
Walking	44%	10%	49%	15%	11%
Bicycle	40%	10%	54%	10%	7%
Car	42%	33%	15%	21%	24%
Bus	22%	10%	68%	6%	6%
Total	**36%**	**13%**	**52%**	**12%**	**10%**

(b) percentage of total trips to Bussum Zuid Railway Staion

	Work	*Shopping*	*Education*	*Visit*	*Others*
Walking	84%	16%	26%	11%	0%
Bicycle	80%	7%	20%	7%	7%
Car	78%	0%	0%	0%	22%
Bus	75%	25%	25%	25%	25%
Total	**81%**	**11%**	**19%**	**9%**	**9%**

Note that in Table A3 the percentages do not add up to 100%, since some passenger have reported their views on more than one mode (i.e., use different entry modes on different days)

Figure 1 Modes of transport to the railway station

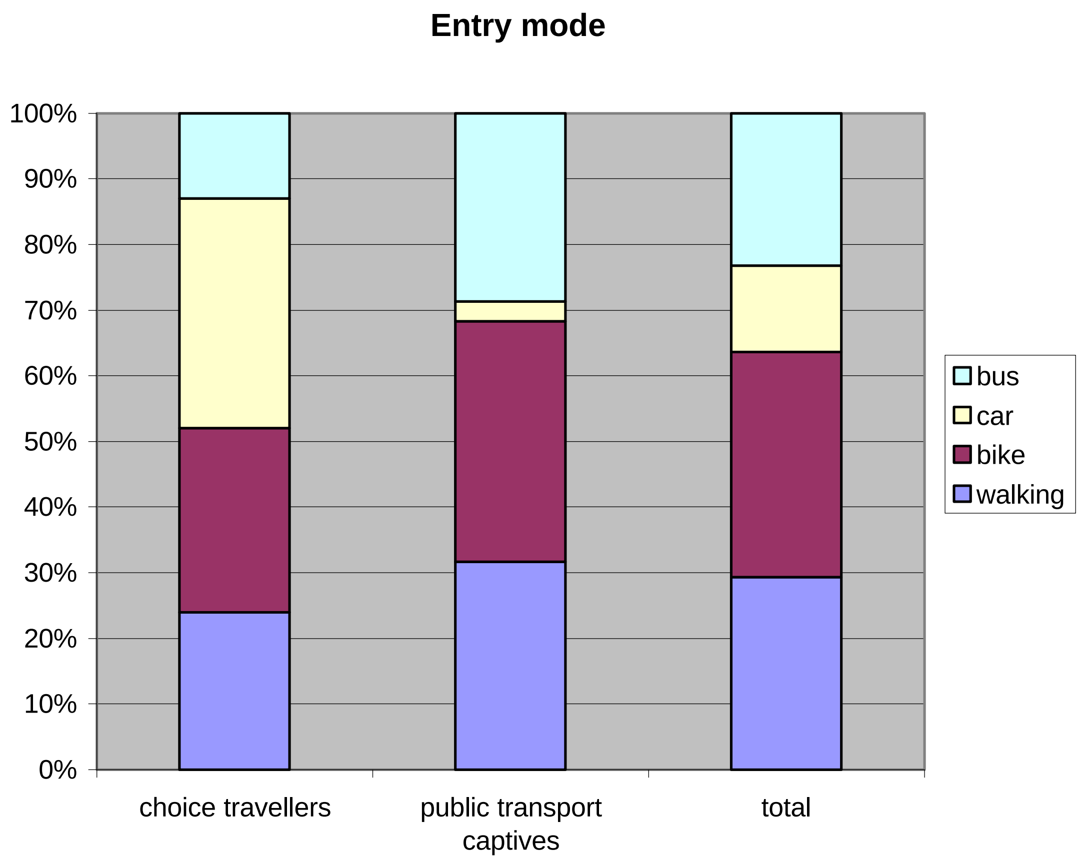
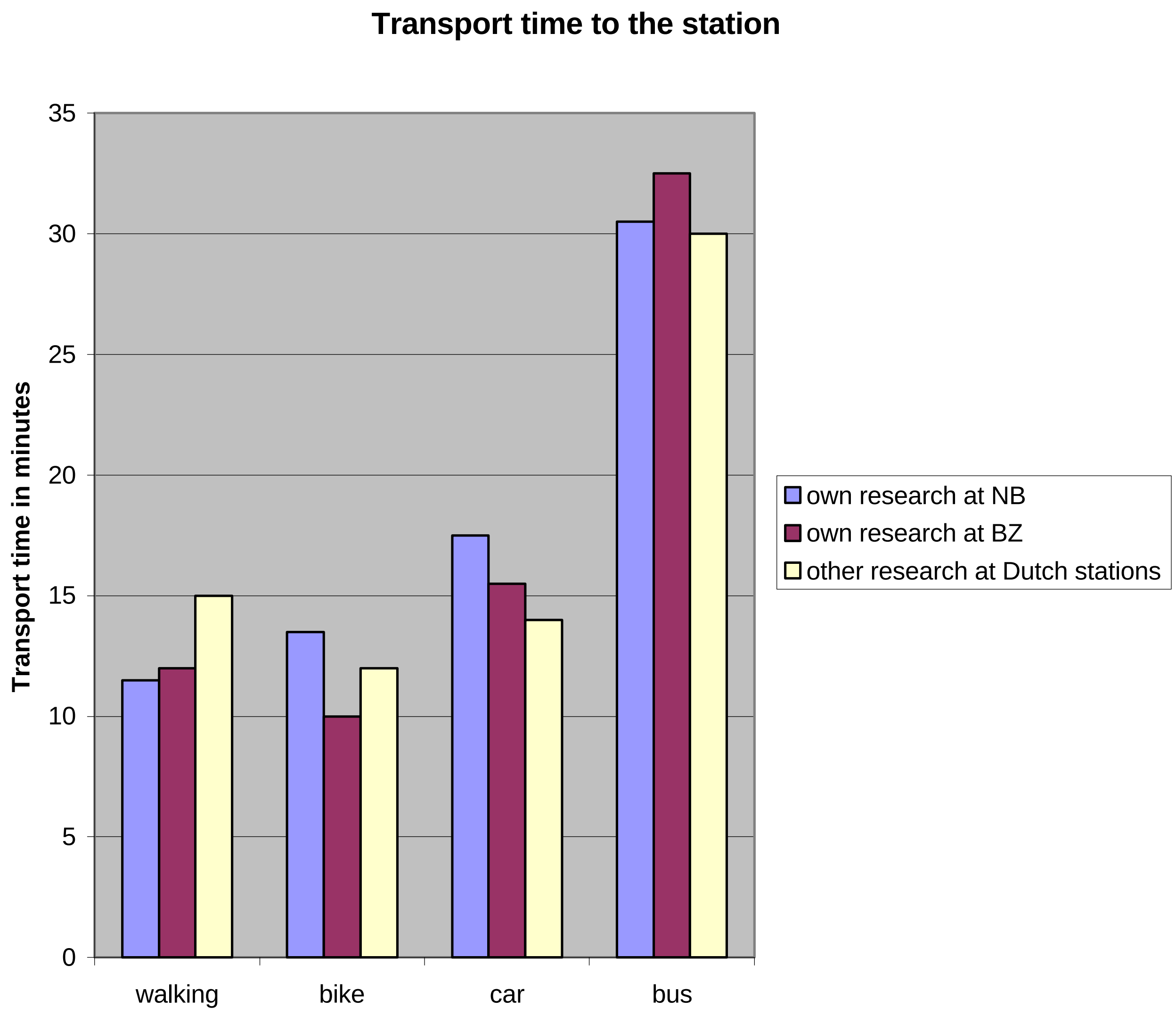


Figure 2 Travel time to the railway station



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