Time in travel
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SUMMARY

In the framework of a study on the effects of a reduction in public transport service levels, a method has been developed to measure people's preferences for departure times of public transport, and to use these preferences in the construction of public transport timetables. Using this method, several timetables were constructed for a bus route in a rural area in the North-East of the Netherlands. The differences in effect of these timetables were then evaluated using a computer simulation program.

The report starts with a description of a number of studies that were concerned with the effects of temporal constraints on travel behaviour. Firstly, Hupkes' "BREVER-wet" (the "Wet van Behoud van Reistijd en aantallen Verplaatsingen", or the law of the conservation of travel time and trip rates; Hupkes, 1977) is discussed. Evidence is brought forward to show that average daily travel times and trip rates are not constant, and that as a result the "BREVER-wet" must be rejected. Next, the UMOT-model (Unified Mechanism of Travel) of Zahavi (1979b) is discussed. After the description of several objections that can be (and are) made against Zahavi's approach, the conclusion is drawn that the behavioural basis of both Hupkes' law and Zahavi's model is very weak.

Secondly, constraint oriented models are described that originate in space-time geography. As examples of this approach the simulation program of Lenntorp (1978) that does not take household constraints into account, and the programs of Recker et al. (1986a, 1986b) and Clarke (1984), that do take care of households constraints, are discussed. The latter program, CARLA, is described in more detail since it is the program that was used in the empirical part of our study. In short, CARLA reorders activities of persons while taking account of institutional constraints (such as opening hours of shops), preferences within the household (such as the desire to have meals together), the logical ordering of activities (for example, dinner must be prepared before one can eat it) and bus departure times. The output of the program is among others the number of alternative activity patterns available to the household, the extent to which these patterns deviate from the observed behaviour of the household, and the extra time spent away from home as a result of the bus service level reduction.

In the fourth chapter a method is described by which preferences for departure times can be measured. To these measurements a trapezoidal distribution can be fitted. The base of the trapezoid, termed the total width of the distribution, gives the time interval in which the person prefers to depart. The smallest parallel side of the trapezoid represents the times at which the individual most prefers to leave, but that are all liked (almost) equally. This time interval is therefore called the indifference region. The individual time preference distributions may be aggregated in three different ways:

1) at each time of the day the preferences may be arithmetically averaged (method "P");
2) at each time of the day the number of persons having a preference greater than zero may be counted (method "C");
3) at each time of the day the average preference (computed according to the first method) may be weighted with the number of persons having a preference larger than zero (as computed with the second method). The resulting distribution ("W") is the product of the distributions computed by method 1 and 2.

On the basis of these aggregated distributions bus timetables can be constructed by allocating a bus departure time to the highest mode of the distribution. Persons whose preference for this departure time is greater than zero are assigned to this departure time. Next, a new aggregated distribution is computed deleting the data of the individuals who were assigned to a bus. These two steps are repeated until all available buses have been assigned a departure time.

In the fifth chapter the study is described, which provided the data that were used in the present study. The study focused on the effects of a reduction in public transport service levels on the mobility of residents in rural areas. The reductions studied were a decrease in service level from 29 runs per day to 11, 7 and 4 runs per day. For the 11- and 7-runs services the Traffic Research Centre constructed bus timetables based on departure time preferences of respondents participating in the study.

A postal questionnaire was sent to a random sample of addresses in the villages Grootegast and Niekerk, lying along the same bus route to the local regional centre, the city of Groningen. The questionnaire gathered information on bus use, household characteristics and car ownership. Households reporting bus use at least once a month (n=105) and a small sample of households reporting travel in the direction of the regional centre, but not by bus (n=26), were contacted again. All members of these households aged 12 or over were asked to keep an activity diary for four days, from Saturday till the following Tuesday. When the completed activity diaries were collected, the households were interviewed about various aspects of behaviour, such as the flexibility of activities. Moreover, household members who travelled to the regional centre were asked about their preferences for departure times. Complete activity diaries were collected from 95 households; on 93 days members of 50 households actually travelled by bus. Time preferences were gathered from 124 respondents.

In the main study, the effects of a reduction in the number of runs per day to 11 and 4 runs per day were studied. Apart from timetables that were constructed according to the usual method (provided by the Ministry of Transport), an 11-runs timetable was evaluated, that was constructed on the basis of the collected time preferences. In a small follow-up study two more timetables were evaluated, with 7 runs per day, one provided by the Ministry and one based on preferences. The effects of these reduced timetables on the activity patterns of households were simulated with the computer simulation program CARLA, developed by the Transport Studies Unit of Oxford University (Clarke, 1984).

Half a year after the first interview 51 bus users in 40 households were interviewed again. During the interview, the respondents were shown the model's predictions of their reactions to the reductions and asked to comment on them. For each tested timetable they were,
furthermore, requested to choose from three possible alternatives the one they preferred most. If they liked none, they were asked to construct an alternative activity pattern while taking the reduced service level into account. When the respondents had made their choices for each of the two 11-runs services, they were requested to choose between the two 11-runs activity patterns chosen.

The results of this study showed that a reduction in service level to 11 runs per day has no large effects. Further reduction however appeared to result in large negative effects, especially for people who depend on public transport: schoolchildren and the elderly. In particular the results of the follow-up study (on the 7-runs timetables) indicated that these negative effects can be diminished when departure time preferences are taken into account. Therefore, the System of Standards for Providing Public Transport in rural areas in the Netherlands should be reconsidered, especially with concern to the minimum level of service. As a matter of fact, the Government is considering several options, among them the use of public transport with flexible scheduling and/or flexible routes.

For the present study, the Traffic Research Centre constructed nine new preference-based bus timetables, using the three methods described previously, for three service levels: 11, 7 and 4 runs. The effects on activity patterns of residents in rural areas were again evaluated using CARLA (Chapter 6). The results of the evaluation showed a significant difference in effects of the preference-based timetables on the one hand, and the timetables provided by the Ministry on the other hand. The three types of preference-based timetables (P, C and W) differed only marginally from one another. Therefore, additional simulations were run to test preference-based timetables with intermediate numbers of runs.

In general, all preference-based timetables proved to be more convenient than the Ministry timetables, except for the journey motive shopping & social. Overall, the three types of preference-based timetables (P, C and W) produced approximately the same results. There are, however, differences in the way specific groups are affected. The Preference timetables favour commuters and schoolchildren, the Counts timetables people who travel by bus for shopping or visiting. The Weighted timetables can be regarded as a compromise: none of the three journey motives is especially favoured. This means that the choice between the three methods is more a political or marketing decision than one based on performance.

The results of the second interview (described in Chapter 7) showed that a majority of the respondents tend to choose an alternative activity pattern that is similar to their observed behaviour. The motivation for the choice within timetables that was most often mentioned, was the similarity to their current behaviour (21%) and the convenient order of activities (28%). Slightly more respondents chose, when requested to decide between the two preferred alternative activity patterns for the 11 P and 11 M timetable, the alternative generated under the regime of the 11 P timetable. The most frequently mentioned motivation was the improved timing of buses (36%).

It appeared to be possible to predict the choice of an alternative out
of several generated alternatives under the regime of one timetable to a reasonable extent (71\% correct) with the help of the disruption index, a measure indicating how much the generated alternative is dissimilar to the observed behaviour. The choice of an alternative out of two alternatives, each for a different timetable, was more often (68\% correct) predicted by the wait index, a measure for the extra amount of time spent away from home as a result of the reduced service levels. The reason that the wait index predicted the choice between timetables more often correctly than the disruption index, is probably the fact that people had chosen an alternative within timetables that was already very similar to their current behaviour.

In Chapter 8 several characteristics of individual preference distributions are described. Preferred departure time intervals for journeys to activities that are relatively flexible in timing appeared to be larger than those for journey motives that are less flexible. Younger individuals have smaller preferred intervals than older persons. An indication was found that household constraints affect the width of the preferred intervals.

The departure-time preferences appeared to be reliable, especially for journey motives that are less flexible. A comparison with begin and end times of school and work showed that school children gave realistic preferences; commuters made some errors, in particular in preferences for the outward journey. This may be caused by the fact that 41\% of the commuters had flexible working hours and/or that 29\% at present drove their car to work. Time preferences for flexible journey motives, such as shopping & social, proved to be less reliable, especially the bounds of the distributions. For these journey motives it may be better to work with the indifference region only. This is not as arbitrary as it might seem: the widths of the indifference regions for these journey motives are very comparable to the widths of the total distributions for the other journey motives (30-55 min).

Several conclusions may be drawn. Firstly, the time at which people wish to travel may indeed be an important determinant of travel behaviour. When preferences are taken into account into the construction of a timetable, the negative effects of a reduction in service level may be diminished. Departure time preferences should, of course, not form the only basis for the construction of timetables, but they can add valuable information to operational considerations. Secondly, the space-time geographical approach used in this study, complemented with attention to household constraints, proved to be very successful in the evaluation of several degrees of reduction in public transport service levels. Although the method is rather data hungry, once the data are transformed into input to the simulation program several simulations may be carried out in a relatively small time period. This presents an advantage over survey methods when a large number of options is to be considered.