Strategy Studies for Urban Transport in the Netherlands

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A strategy study is described that was undertaken in the Netherlands in order to develop and test transport policies. The transport context was that of the decline of the traditional Dutch bicycle mode, since trip distances have increased, and the growth of car use, which has led to more-dangerous and congested traveling conditions. Promotion of bicycling and public transport and restraint of car use were therefore policy objectives. In the most recent study completed for preparation of policies for the early 1980s, a demand model was employed that used disaggregate data from the Amsterdam area collected in 1976. Several different strategies were investigated for shifting traffic from car to bicycle or public transport. Particular care was taken to ensure that policies tested were both technically and economically feasible. The findings indicate a number of interesting policy considerations. Aggregate study tests showed a considerable sensitivity to bicycle disutility; i.e., quicker or more-pleasant conditions caused a considerable shift toward the mode. Changes in the quality of public transport did not generally show much potential increase in demand, with the exception of one area of deficiency in Amsterdam in which improvements in the network produced a 10 percent increase in public transport use but car traffic decreased only 2 percent. The study indicated that an important influence on car use might be the introduction on an extensive scale of company buses, vanpools, and other similar arrangements. The economic feasibility of this option was not tested, however. The results of the study have to be looked at with some care, given some doubts as to the explanatory power of the models used. It is hoped that in future strategy studies a model can be used that will be based on a real understanding of the decision processes.

Short-distance passenger transport in the Netherlands has traditionally relied on the bicycle as its main mode. Even now, 53 percent of all vehicular work journeys less than 4 km are made by bicycle, as well as 46 percent of other home-based journeys in the same distance category (1, pp. 18 and 37).

Car ownership has been increasing rapidly during the past 20 years and often results in use of this mode for most trips.

A more-important factor, however, has been the change in land use. The population density of cities has decreased considerably. This is largely explained by the demand for better housing and the trend toward smaller family units (more single people are occupying dwellings that were formerly occupied by families). The big cities have grown to the extent that now some journeys inside the agglomeration are too long for bicycling and therefore people have changed to public transport or, in most cases, car. Also many people have moved out of the cities even though they continue to work there and, for these journeys, the bicycling mode could only attract a few enthusiasts.

Government policy could not prevent people who work in cities from occupying much of the new housing in small villages and for them the difference in quality between public and private transport has been such that the private-car mode is predominant. Even between planned new towns, which are well served by public transport, and the main cities, an appreciable share of traffic is by car. The reason is the convenience of this mode and the fact that destinations (jobs, shops, etc.) are sometimes at considerable distances from the city center.

These developments have greatly increased the number of cars on city streets, which results in strong competition among bicycle, car, and public transport for road space. Bicycling has become more dangerous and also slower because of the introduction of traffic lights that give a green wave to cars and a red wave to bicycles. Trams and buses are held up in traffic and also hindered by traffic lights, and this makes this mode less attractive to passengers and more costly to operate.

During the early 1970s, transport policy gradually changed from a following-demand approach (i.e., one responsive to the demands of users) to selective policies that introduced restraint on car use. Long-term parking was restricted by the introduction of parking meters. Also, priority schemes for trams and buses, which includes segregated tracks for trams and lanes for buses, were introduced and bicycle routes were constructed to promote this least costly energy-efficient mode of transport (2, p. 49).

After a short period of metro (heavy rapid transit) construction, the central government realized that this mode was not justified in cities the size and structure of the large Dutch cities, and attention was given to extension of the existing tram (light rapid transit) networks. In Utrecht, the fourth-largest city in the Netherlands, trams will be reintroduced on a new suburban line.

EARLIER STRATEGY STUDIES

During the preparation of the first Medium-Term Passenger Transport Plan (MPP) for 1976-1980, studies were made of alternative transport strategies for the urban areas in and around Amsterdam, Rotterdam, and Tilburg.

The purpose of these studies was to obtain information on the possibilities of influencing car use where undesirable side effects, such as occupation of too great a proportion of the available space, deterioration of road safety, pollution, noise, and road congestion, made the unlimited use of the car undesirable or even impossible.

The following is a summary of the Amsterdam study, for which a report is available in English (3).

The main part of the strategy study is concerned with the estimation of the influence on demand for passenger transport of a number of alternative policies. The demand model used belonged to the family of models first used in the SELNEC study (4) with minor adaptations to take account of the Dutch situation. The results of a household survey in 1966 provided the main data for this adaptation.

Travel impedance was expressed in generalized time or generalized cost divided by the coefficient of in-vehicle time. An exponential function of the general form [exp ($-\beta c$)] was used in a two-way mode split--first for car owners, to obtain the split between bicycle and car plus public transport, and then for the split between the latter two. For those who do not own cars, of course, only one split was needed. Distribution was done on the basis of a log sum, which combined car and public transport impedances. Five strategies were tested: (a) doing nothing; (b) having a higher cost of car use or more congestion (since monetary cost and travel time are combined in one generalized time function, a higher value of this function can stand for a rise in money cost, a longer travel time, or a combination of both); (c) having better urban public transport; (d) the same as (c) but also with higher fares; and (e) the same as (d) combined with higher cost of car use [but less than in (b)].

It was found that providing better public transport could not by itself produce any significant shift from car to public transport. This could only be brought about by either higher costs of car use or a combination of higher car cost and better public transport. This was an important conclusion since it ran counter to the argument put forward earlier (and even now) that people would be glad to leave their cars at home if only public transport would give them better service.

In line with the results of this study, the MPP 1976-1980 contained a package of measures that aimed at selective restraint of car traffic by an active parking policy that favored short-term parking, very few improvements to the urban road system, and only limited extensions of the main roads around the larger agglomerations; thus a deterioration in traffic conditions was accepted.

A rise in the price of gasoline was planned but could not be brought into effect in view of the effects at the borders. Road pricing was mentioned as a subject for study, but even though calculations of the effects of an area-licensing scheme for Amsterdam were made (5), no action in this field has been undertaken so far.

The quality of service of public transport should be raised by providing more tram and bus lanes and new lines to serve the expansion areas of cities and new towns; elsewhere, the level of service should be adapted to respond to changes in demand.

NEW STRATEGY STUDY

When the preparations for a new MPP, which would include 1980-1984, were started, the possibility of making new strategy studies was considered. The reason for this was not so much that doubt was cast on the conclusions of the earlier studies but that, since 1975, new model estimations had been made that aimed at a policy-sensitive demand model for the Amsterdam area by using data collected in 1976 (6,7). This model had the advantage over the earlier one of being based fully on data collected within the study area and of using estimation techniques that were considered to be the best available.

Another advantage was that the traditional distinction between those who do and those who do not own cars was replaced by a car-availability factor. For home-based work trips, this was calculated as a proportion between workers who had a driver's license and cars in the household. For other home-based trips, a car-remaining factor was calculated and, if all cars in the household were used for work trips, the other home-based trips made during working hours were put in a separate category for persons who owned a car but whose car was not available. In this way a change in mode choice for the journey to work has an influence on mode choice for other journeys.

A program was set up that consisted of the development of a base strategy (no change in transport policy) and the calculation of the traffic flows to be expected in the study area--road and public transport loadings derived from total trip matrices by mode and travel purpose. A certain number of general policy options were then to be considered for the whole study area and the consequences calculated for the sample of trips that were used for estimations. Finally, one or two options were to be developed into a realistic network to provide better public transport on a selective basis, i.e., where a potential demand existed that was not sufficiently catered to for the base network. These networks were then to be used for new forecasts of traffic flows. It was intended that the additional costs and revenues of providing better public transport should also be calculated.

Unfortunately, the model, estimated on a disaggregate basis, proved difficult to use for the calculation of a matrix of trips for the study area. It is not the purpose of this paper to tell the sad story of what has been called aggregate validation (1,8,9). This process is comparable to traditional calibration, the main difference being that it had to be done with far fewer data. After a lengthy process, it was eventually possible to use the new models for aggregate forecasting, with the exception of the home-based work-destination choice model, which was considered to be weak as a result of the aggregate validation (10).

The delay incurred made it impossible to complete the studies in time to use the results for the preparation of MPP 1980-1984, and abandoning the project altogether was considered. However, it was decided to proceed with a limited program, which was to be ready in time for the discussion of the plan in Parliament. This decision was promoted by remarks made by a member of Parliament stating that an active policy of providing better public transport should be followed to attract people away from use of their cars, a statement contrary to the conclusions of the first strategy study. It was of course worthwhile to see whether this conclusion would still hold when the new model was used.

BASE STRATEGY

The base strategy was formulated for 1985. This year was chosen mainly for practical reasons: The land-use and other data that are necessary for a run of the model had already been collected for that year, and a year some five years away seemed realistic for medium-term planning.

The networks were based on the existing situation and included those additions that had already been planned. Parking capacity was based on the traffic circulation plan for Amsterdam, which severely limits the number of long-term parking spaces available to workers throughout the agglomeration.

Modal probabilities were calculated by using the travel disutility derived from the Stadsgewestelijk Individueel Geschat Model [Individually Estimated Conurbation Model (SIGMO)] study and were then applied to an existing home-based work matrix. Next, the number of cars that remained was calculated and applied in a full run of the other SIGMO home-based model. This process is equivalent to the application of the SIGMO models described in an earlier paper on the use of these models for railway investment decisions (8).

The demand forecast for the base strategy was used not only as a basis for comparison with other strategies to be tested, but also as the starting point for the development of these strategies. They were meant to be realistic, that is, both technically and economically feasible.

Technical feasibility of a change in the public transport system can only be guaranteed if changes in the network are determined individually by the introduction of new infrastructure or public transport lines; by changes in the speed of the car, bicycle, or transit traffic; or by changes in frequency of public transport.

On railways and the metro, speed is given by the technical characteristics of the network and rolling stock. On many tram and bus routes, speeds are already at the highest possible level; on others, however, the introduction of tram or bus lanes and regulation of traffic lights so as to give priority to public transport vehicles is feasible. A higher frequency on a line that already has a very high one does not make sense or may not even be technically possible because of restrictions in line or terminal capacity.

Economic feasibility means that there should be a demand for better service: It is not sensible to provide good public transport between areas in which there is low traffic demand, because it can in no way influence car traffic appreciably.

Analysis started by studying sector-to-sector relations on a nontraditional basis. Normally the full matrices that result from destination-choice and mode-split calculation are condensed in matrices containing at the most 19 sectors. Each of these sectors consists of a combination of adjacent zones that can easily be printed and inspected. In this case, a distinction was made between zones near railway stations and zones far away from railway stations, and relative differences in mode choice were studied.

Unfortunately, this analysis was not very conclusive. The reasons for this might be not only an inappropriate combination of zones into sectors, but also the values of the coefficients in the disutility (generalized cost) function. In fact, coefficients for walking and waiting times are very high compared with in-vehicle time (5-10 times the latter, instead of the usual 2-3). This makes the relatively slow bus, which is available anywhere, attractive compared with the fast trains that generally have a longer access time.

Another analysis was directed to find areas or routes in which public transport probabilities were low compared with those of the car. The results of this analysis will be mentioned below.

AGGREGATE STRATEGIES

As a side product of the SIGMO study, a sample enumeration system was developed that can be used to calculate quickly the impact of general changes in the independent variables of the model on destination and mode choice of the trips that are in the 1976 sample for Amsterdam (11).

A general change in car speeds was not a policy to be tested, since it was expected that the diminishing capacity of long-term parking would keep traffic flows reasonably within the available road capacity. Use of traffic congestion to limit road use is not being considered by the present government and, even if there is a tendency to raise the variable cost of using a car, this would not show any change in the outcome of at least the home-based work model, since this contains no coefficient for monetary cost.

As has been said earlier, bicycle traffic is being slowed down by traffic lights and road congestion; moreover, many people consider bicycling to be too dangerous. A test was therefore undertaken in which bicycling times were reduced by 30 percent. Bicycle use appeared to be very elastic: Bicycling from home to work went up by 36 percent and from home to other destinations (excluding school) by 41 percent. The following table gives further details about the mode split after the test:

Trip Type and Mode	Change (%)	Percentage of Total Trips: Before	After
Home-based work (excluding walking)			
Bicycle	+36	29	40
Car	-12	32	28
Transit	-22	28	22
Home-based other			
Bicycle	+41	37	53
Car	-13	26	22
Transit	-32	35	23

A change of 30 percent in bicycling time may seem considerable. It has, however, already been said that in many cases a series of traffic lights can slow down bicycle traffic considerably. Also, one-way schemes and large-scale layout of junctions, both meant to facilitate car traffic, make bicycle trips longer. Furthermore, we should realize that the propensity to use a bicycle is dependent not only on the bicycling time, but also on the coefficient of this time, which is the negative value to personal well-being of a minute of bicycling. This value is influenced by a number of factors, and recently a study was started to determine which factors are most important for determining attitudes toward bicycling. For example, if many find bicycling dangerous, providing protected bicycle paths may influence the negative value of bicycling time.

The main purpose of the study was to see to what extent better public transport could promote a shift from car to transit. In the SIGMO study, the coefficients for out-of-vehicle time were, at least for the journey to work, far higher than those for in-vehicle time. It was therefore natural to consider strategies that produced a lower out-of-vehicle time.

Three options were open:

1. Shorter access and egress times, to be realized by a denser network;
2. Shorter waiting time; and
3. Elimination of interchanges.

The last was chosen: Transfer waiting times were eliminated. In practice this can be realized by offering a through service to all passengers or by providing planned interchanges; i.e., a vehicle of a connecting line leaves immediately after the arrival of the vehicle that makes the connection.

Public transport home-based work trips increased by 12 percent and home-based other trips by 21 percent. If these changes are compared with the relevant trips (that is, those trips with at least one interchange), then the influence will of course be greater. The table below gives the details:

Trip Type and Mode	Change (%)	Percentage of Total Trips: Before	After
Home-based work			
Transit	+12	28	32
Bicycle	-5	29	28
Car	-6	32	30
Home-based other			
Transit	+21	35	42
Bicycle	-17	37	31
Car	-3	26	25

NETWORK STRATEGIES

In reality, changes in the quality of the transport system will never be of the same proportion throughout the network. Technical and economic contingencies will cause the changes to vary from none when there already is good service or no demand to very considerable when there is a missing link in the network.

In general, the quality of service on the public transport system of the base strategy proved to be very satisfactory, and few possibilities were available to speed up services. Apart from a few isolated links, there was a general deficiency in quality of service only in a region southwest of Amsterdam. New services were introduced and frequencies changed on order to cater more effectively to the demand in this area.

Following the promising outcome of the SIGMAT test for the elimination of transfer waiting times, the public transport assignment of the base strategy was searched for important transfer movements between two lines or directions, and through services were introduced where appropriate. In some cases it was possible to link two lines that terminated at the same place, and sometimes lines were diverted, with possibly a loss of frequency or even of an existing through service. As a result of these changes in the network, the overall share of public transport for the journey to work rose by more than 10 percent, with a corresponding fall in car traffic of only 2 percent. The modifications would of course have been more important if they had been compared only with trips between zones that were affected by changes in the network.

The SIGMO model distinguished only walk, bicycle, public transport, and car as available modes for the journey to work. Shared ride or carpool, minibus, company bus, subscription bus, and similar intermediate forms of transport are not included. In fact, group transport (buses provided by the employer) is used to an important extent by workers at Schiphol and at Hoogovens (the blast furnaces and steel works at Velsen) in the two outer areas of these underserviced zones. These forms of transport are less frequent to other destinations but far from nonexistent.

It was therefore decided to study the effect of giving the opportunity of using these forms of transport to all workers who live outside the agglomeration, since they provide better service than the normal public transport network of the base strategy. Workers who live in Amsterdam were considered to have sufficient traditional public transport services available.

This was done by using the highway network as a spider network for company buses after having scaled down the speeds by 20 percent to allow for the lower speeds of buses versus cars and the stops and detours to pick up passengers. A walk link that averaged between 5 and 10 min was introduced between the zone centroids and the highway network (since it cannot be expected that every worker will be picked up in front of his or her home) and a waiting time of 10 min (one way only) to allow for irregular running of the buses.

The coefficients of the public transport mode were applied to the walk, wait, and in-vehicle time obtained from this network, which implies that traveling in a company bus is considered to be as unpleasant as traveling in a public service vehicle. This hypothesis of course needs to be tested on the basis of appropriate data before any conclusions from this research can be transferred to actual policy.

"Parabus," as the hypothetical system was called, proved to be more attractive than traditional public transport for more than 60 percent of the trips generated outside the agglomeration. Substituting parabus disutilities for those of public transport gave an increase in use of the combined modes of 76 percent, with a corresponding drop in car traffic of 13 percent. One should realize, however, that the calculations were made on the hypothesis that parabus was always available. In practice, however, this form of transport can only be provided if a group travels on a route at approximately the same time. But even if this mode could only be made available to 20 percent of the workers, its effect would already be stronger than that of either a better public transport network or the elimination of transfer waiting times. It may be of interest to start a feasibility study of a parabus system.

These and other ancillary calculations can, however, be made later.

CONCLUSIONS

The strategy studies show that there are several options available to promote the use of public transport. However, the conclusion of the first strategy study that provision of better public transport could not by itself produce a significant shift from car to public transport has not been refuted, since the influence on car traffic is very limited.

The parabus system may be a more-successful means of reducing car traffic than providing better public transport, but this provisional conclusion needs to be studied further to determine (a) where and for which commuters parabus can be provided in practice and (b) the disutility or generalized cost of this mode, or at least the validity of the hypothesis that the coefficients of this mode are similar to those of public transport.

Unfortunately, a procedure followed in the model estimated for trips generated in Amsterdam has not been followed in the estimation for trips generated outside the agglomeration: In determining car availability for home-based other trips, the fact that all the cars available to the household are already on a work trip has been accounted for and therefore the effect of fewer people who use their cars for the journey to work in this mode or for other journeys can only be determined for trips generated in the agglomeration.

The importance of the validation coefficients introduced after the estimation of the model can give rise to serious doubts as to the explanatory power of the model. The functional form itself (multinomial logit) is sometimes criticized, and the disutility functions have some strange elements--no cost factor and extremely high coefficients for out-of-vehicle time in the home-based work model and a positive coefficient for in-vehicle time of more than 20 min in the home-based-other model for trips outside the agglomeration, to cite just a few very striking examples.

If a third series of strategy studies is ever undertaken, it is hoped that a model can be used that will be based on a real understanding of the decision processes that determine behavior. From this better understanding, relevant factors for the decision of users may be identified, so that data can be collected and analyzed that will have sufficient variability in these factors. Also, model building should be based on the theories of the behavioral sciences and not on mathematical considerations, as is now often the case. Developing this type of model will provide the experts with a great deal of work that, to some extent, will require different skills than those now being applied in the field.

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Use of Incremental Form of Logit Models in Demand Analysis

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Many transportation systems management policies are geared toward making minor changes in the level of service (LOS) provided by transportation networks in an urban area. Estimation of changes in travel demand is usually prerequisite to assessing the costs and benefits associated with such policies. The pivot-point technique, which uses the incremental logit model, is especially suited for this type of analysis. This procedure predicts revised travel behavior based on existing travel behavior and changes in LOS experienced by a trip maker. The major advantage of this procedure is that no knowledge of detailed existing LOS data on all relevant alternatives available to a trip maker is required. Only estimates of existing market shares and proposed changes in modal disutilities are necessary. Based on the values of the coefficients of travel time and travel cost reported in transportation literature, default values of the coefficients of in-vehicle travel time, out-of-vehicle travel time, and out-of-pocket travel cost have been suggested. These coefficients can then be used to calculate the changes in modal disutilities due to changes in travel time, travel cost, or both. The use of this technique is discussed by using a case study.

More and more, transportation planners are being asked to consider low-capital short-range transportation system management (TSM) solutions prior to justifying transportation improvements such as fixed-guideway transit facilities and limited-access highways in an urban travel corridor to alleviate traffic congestion. Some of the management strategies for shifting motorists to public transportation modes involve consideration of changes in headway, routing, and fare structure; preferential treatment; signal preemption; and express service and route extensions. Operating strategies for discouraging the use of the automobile on the highway system may include consideration of preferential treatment for high-occupancy vehicles and, at certain locations, parking restrictions, parking-fee surcharges, or both. Such strategies should also be analyzed in the preparation of a state implementation plan for the attainment of air-quality standards and of an energy contingency plan. Transportation analysts are invariably asked to assess the impacts associated with such changes. Assessing changes in travel demand for the subject mode and competing modes is usually prerequisite to estimating impacts on energy consumption, air and noise pollution, fare-box revenues, and operating expenses.

It is usually difficult to estimate the changes in travel demand by using the classical Urban Transportation Modeling System (UTMS). Many binary mode-choice modeling techniques developed during the 1960s (1) have proved to be ineffective in computing the changes in travel demand. These techniques were primarily designed for system-level transportation and land-use studies and could not easily split the travel demand among the several competing transit and automobile mode choices usually present in a large metropolitan area. Since these models cannot adequately simulate the equilibrium flows along competing transit routes, changes in travel demand due to minor changes in level of service (LOS) cannot be accurately estimated.