TRANSPORT POLICY EVALUATIONS WITH A LARGE SCALE MODEL

Jan van der WAARD
Senior Project Manager
Ministry of Transport
and Public Works
Rotterdam - The Netherlands

Piet VROLIJK
Associate
Hague Consulting Group
The Hague - The Netherlands

INTRODUCTION

In 1990 the Dutch parliament agreed upon the 2nd Transport Structure Plan describing the long term (up to 2010) transport and infrastructure policy. This policy aimes to solve a number of increasingly pressing problems, which are brought about by ever increasing use of private vehicles:

- congestion and deteriorating accessibility;
- pollution and energy consumption;
- impaired traffic safety.

The new transport policy tries to deal with the unacceptable scale of these negative effects, by setting certain maximum and minimum targets for accessibility and a number of environmental aspects. In order to satisfy these objectives numerical targets for growth of certain mobility categories are indicated in TSP-2 as indications for the effects which the policy measures must achieve; for instance a maximum of 35 % growth of car-kilometrage by the year 2010 (with respect to 1986). A number of policy measures are introduced as means to achieve the objectives:

- reduction of car use through pricing policies, improving of travel alternatives, land use planning, peak spreading etc;
- improving accessibility by public transport through service improvements and construction of new infrastructure;
- increasing road capacity by widening of existing roads, building new ones and improving the use of existing infrastructure.

1. THE USE OF THE NATIONAL MODEL SYSTEM

To evaluate the different policy measures within TSP-2 the National Model System (NMS) has been used. The NMS is a statistical model for the estimation of current and future mobility characteristics of the Dutch population on an average working day. These mobility characteristics include: licence holding, car ownership, number of trips, passenger kilometres, travel hours, travel costs etc., split by travel mode and time of day.

These characteristics are determined separately for each travel purpose (commuting, business, shopping, education, etc.) and by traveller category (by age, employment etc.).

On this basis the following indicators are provided for the trunk road network: vehicle kilometrage and vehicle hours, in the peak and total for 24 hours; time loss waiting in traffic jams in the peak; road sections and road length with structural traffic jams in the peak. This basic data can be used to derive travel speeds, car occupancy etc..

The NMS distinguishes between traveller groups according to household type, employment, age, etc. The mobility patterns within each group are relatively homogeneous, but they differ markedly between the groups. The behavioural preferences of the various groups are derived from extensive travel surveys.

In the first step the future size of each of the groups in estimated. Next, the conditions that determine mobility (such as travel times and costs) are derived from the characteristics of the policy scenario. Then the mobility characteristics are calculated for each group separately.

The calculation of mobility is performed with a series of choice models. There are separate choice models for car ownership, driving licence holding, travel frequency, mode and destination choice, time of day and route choice. All these models calculate the probability of choices from the set of alternatives available to a particular type of traveller depending on personal characteristics (e.g. employment, age) and on the conditions in which he makes his choice (e.g. travel times and costs for the competing modes).

The parameters of these models, which describe the relative importance attached to those conditions by the traveller groups distinguished in het NMS, are derived from extensive travel surveys.

For the NMS, The Netherlands is divided into 345 zones. For each zone an estimate is made of the size of the market segments. To calculate the level of service for alternative modes, there is even a division into 1132 zones, linked to the national trunk road network and the rail network. A more detailed description of the model system is given by Daly et al., (1985 and 1988).

The model system was used to determine the impact of the many different measures and combinations of measures introduced to control travel demand and congestion on the main road network. In this way the effectiveness of a particular measure could be analysed, as well as the extent to which the whole package of measures achieved the targets.

For the purpose of these analyses three scenarios were distinguished with respect to future demographic and economic changes. In order to provide a comparison with the estimates for TSP-2, an Unchanged Policy scenario has been constructed, which in essence reflects the continuation of the policy from the First Transport Structure Plan (some 15 years previously).

To be able to analyse as many as possible of the new policy measures, considerable attention was given to the implementation of the different policy measures in the model system. For instance, special attention was given to the introduction of parking restrictions within the major cities and to the suggested improvement of the public transport system, especially in corridors where the public transport market share is most likely to increase.

The model analyses show that continuation of the present policy would lead to substantial increase in traffic volumes and delays, leading to undesirable levels of the negative aspects of transport. The various factors that cause this future growth of travel demand will be described.

2. PROSPECTS UNDER UNCHANGED POLICY

In recent years, car mobility has increased annually by nearly 4%. Car traffic on the main trunk road system even increased by approx. 6% annually. Whilst much of this growth is driven by factors which will not continue to grow in the future (the 'Dutch Job Miracle', in particular) the public is increasingly aware of the problems such growth can generate.

Future mobility development greatly depends on the development of exogenous factors such as population and economy. In addition, the growth of driving licence holding, the level of car ownership and the quality of the infrastructure are all influential in the growth in mobility.

Based on forecasts from the CBS (the Central Bureau of Statistics) and from the CPB (the Central Planning Bureau) for demographic and economic developments respectively, and the corresponding forecasts for driving licence holding and car ownership, mobility will increase by approx. 31% in 2010 (reflected in person kilometres, for all purposes and all modes).

Because the number of trips only increases by 9% this means a significant increase of average trip distances. The share of the car will increase from 64% in 1986 to 74% in 2010. Absolutely, the car kilometrage will increase by 70%, resulting in a serious increase of the above-mentioned negative effects. The remaining modes increase less rapidly than total mobility so that their shares in total mobility decrease.

3. THE NEW POLICY OF TSP-2

With regard to the principal aim (accessibility) and preconditions (environment, accident risk, etc.) the Transport Structure Plan formulates minimum or maximum quantitative objectives, to be reached in 2010. In respect of the accessibility aspect the following target values have been formulated:

- direct links via the main road network (detour factor 1.4 or less) between 40 urban centres
- minimum quality for traffic management on the main road network: no more than 2% probability of congestion on hinterland links, no more than 5% on remaining links of the main road network
- priority for freight transport and business traffic.

Whereas the instruments of the TSP-1 policy consisted practically entirely of improvement and extension to infrastructure, the TSP-2 is mainly based on a number of new types of instruments. Main groups are the introduction of improved technology, pricing measures, selective improvement of the road infrastructure, improvement of alternatives to car, and a series of organisational measures. These instruments are described in detail in the TSP-2 document (Ministry of Transport, 1990).

All selected instruments contribute directly or indirectly to reaching the set of targets. Mobility change (mainly the reduction of car kilometrage) should be considered an intermediary step on the way to reaching the main targets. To be able to meet the objectives, target values have been indicated with regard to the development of some mobility categories:

- until 2010 car traffic would be allowed to grow by approx. 35%
- average car occupancy in commuter traffic should increase from the present 1.2 to approx. 1.6 in 2010
- the use of public transport should increase by 50-100% during peak hours in important corridors.

Extension of the use of public transport is no aim in itself within the TSP-2 policy. The improvement of public transport is mainly directed towards car traffic reduction and its ensuing effects.

Government investments in public transport and operating deficits in public transport constitute approx. 50 billion ECU's, (being 70% of all planned government expenditure up to 2010 related to TSP-2). For the main road network some 15 billion ECU's has been budgeted. These figures illustrate an obvious change with respect to TSP-1: greatly increased investments in public transport versus decreased road investments.

4. IMPLEMENTATION OF TSP-2 IN NMS

4.1 Approach

During the preparations for the TSP-2, analyses have been made, with the help of the National Model System, on the effectiveness of individual measures and on the package of measures as a whole (see AVV, 1990 and Daly et al., 1988 for details).

A so-called Unchanged Policy Scenario has been constructed to compare with the TSP-2 estimates. For the TSP-2, various policy variants have been adopted which differ in the mix and severity of the measures involved. In this paper we will discuss the 'basic' policy and two 'extra' policies which have been developed to achieve a further reduction of car traffic.

4.2 Measures studied

Not all measures from the TSP-2 are immediately suitable for quantitative analysis. A large number are insufficiently specified and relatively vague (e.g. car pooling). For other measures it is not yet clear how they will work out because there is no practical experience with them yet. The following measures are included in the estimates:

- Improved technology
  - more economical and cleaner vehicles
  - improvement of energy efficiency of vehicles
  - reduction of speed limits in build-up area's
- Pricing policy
  - levying tolls on a cordon around the Randstad
  - increasing fuel taxes
  - doubling parking charges and area of paid parking
  - changes in tax deduction of commuting travel costs
  - increase of public transport fares
- Road infrastructure improvement and extension
  - 12% expansion of trunk road network (removal of bottlenecks)
  - 15% expansion through extra lanes (road widening)
  - 10% autonomous capacity growth per lane (unchanged policy)
  - 5% capacity growth per lane (as policy)
- Quality improvement of alternatives for car use
  - introduction of Rail 21 plan for network structure and service levels
  - speed increases on the basic public transport network
  - introduction of peak-hour buses on heavily used car corridors
  - reduction of the travel time ratio for public transport against car to 1.5 on the most heavily used commuter routes
  - introduction of public transport information systems
  - improvement of bicycle infrastructure
- Improvement of freight efficiency
- Physical planning (land use policy) and timing policy:
  - application of location type systematics
  - parking restrictions at certain locations.

4.3 Detailed description of the main measures

In the next sections the most important measures will be discussed in some more detail

4.3.1 Measures concerning road traffic

Toll cordon Randstad. Tolls will be collected from all traffic entering the Randstad area (e.g. the large urbanised area in the Western part of the country). It is assumed that at some 15 locations on the main trunk road structure there will be toll plazas. It is the intention that it will not be possible to avoid these toll plazas on entering the Randstad area. The tariff will be indexed to income changes. The extra travel costs are included in the average generalised travel costs for the mode and destination choice. Route choice is not intended to change. The petrol price will be increased by 25 % over the 1986 level in the unchanged policy (as a result of trends in the world market prices) and with an extra 30 % according to TSP-2.

Speed reduction in urban areas. The speed limitation in the build-up area's (to 30 kph) is simulated by adding 20 seconds to the travel time by car for each origin or destination zone which has a population density of more than double the national average. The 106 affected zones cover about half of the total population. Note that the system feeds back congestion delays to the mode and destination choice models.

Parking restrictions on two location types. The first type of locations (labelled A) are sited close to public transport of national or regional importance. The employment density is high and there are few parking facilities. The second type of locations (labelled B) are close to public transport connections of local or regional level, and near a major local road or motorway connection. Employment density is lower than for the A-locations and more parking facilities are available. The TSP-2 gives limits for the maximal number of parking places allowed for work related car-trips related to the number of working places within the area. At the moment there are no adequate models to compute the effects of these location specific policies. Therefore, it was assumed that measures would be taken to ensure that the total number of trips going to those zones would not change (e.g. employer based incentives to switch mode). The unconstrained demand for parking space was determined and the surplus of demand over supply was divided over all other modes in ratio to their share in the undisturbed situation for each zone-pair.

Road infrastructure improvement and extension. TSP-2 suggests a selective investment scheme to ensure accessibility on economically important routes and accepts some delays on other roads.

4.3.2 Measures concerning public transport

The way specific public transport methods in the model have been implemented is detailed below.

Introduction of a three tier network system (EuroCity/Inter-City, inter-regional and regional/urban). This system of rail transport is characterised by a high service level for the short distance and the peak hours, and a restriction both of the number of links and of the speed of the international and interregional movements. The network description and timetable made available by the Dutch Railway constitute the basis for the determination of travel, wait and transfer times.

Speed increase on basic network for the buses. The travel times by bus have been reduced by 20%. A differentiation according to distance class was applied, since for long interlocal (> 15 km) trips an increase of 20% is not deemed realisable.

Introduction of peak-hour buses between the 100 origin-destination pairs with the heaviest car traffic volumes over > 15 km. These zone-pairs have been translated to 692 subzonal pairs. During peak hours a bus service is assumed with a travel time equal to that of the car without congestion. Apart from being an alternative to the car, the peak-hour buses inevitably constitute an obvious competitor for the train because of their operating characteristics.

Improvement of present public transport on the 500 heaviest commuter movements between zones with distances between 5 and 25 kilometres in such a way that the travel time ratio by public transport and car does not exceed 1.5. Almost all of these relations are to be found in the Randstad area. On 97% of the relations concerned it appeared necessary to adapt the ratio travel time by public transport/travel time by car. The average ratio before adaptation amounted to approx. 2.8. The improvement of travel time by public transport has been applied to the model by proportional improvement of all components of the trip (including access times). The average time saved after adaptation amounted to 19 minutes. For such a change an adaptation of the public transport system is necessary. It is stressed here that desirability and/or feasibility of the improved public transport links have not been checked for any origin/destination pair selected. Only modelled public transport improvements at an urban district level are described here.

An annual (real) increase of the train fares of 1.3% on average has been used (36 % over the whole planning period of 24 years). For the train it was assumed, based on available analysis from Holtgrefe (1985), that this increase will on average influence kilometer costs for the traveller for 75%. This is partly the result of the wide range of tickets offered by the railways providing great freedom to the traveller to compensate fare increases by choice of ticket. For the remaining public transport it was assumed that such compensational behaviour is possible to a much lesser degree, making the rate increase influence kilometre prices by the full 100%.

Improvements in travel comfort. In addition to the earlier-mentioned improvements in the field of service quality, significant improvements in travel comfort have been planned. At this moment there is insufficient knowledge to be able to quantify the effect on the use. It remains to be seen, however, whether this kind of measure will lead to reduction of car use, as within the car system quality improvements are also to be expected.

4.3.3 Implementation of the 'extra' scenario's

The base package of policy measures described above was developed to reduce the expected level of car kilometrage from index 170 to about 150. In order to reach the target value of about 135, two extra scenario's were postulated. These are referred to as: the toll+ and fuel+ package. They are equal to the base package, but each is more severe on one particular aspect.

The toll+ package assumes that the elementary system of toll in the base scenario has been extended to a system like road pricing; all over the country drivers would have to pay for the use of the highway system. The tariff would depend on time and on location (on average the price of driving would be doubled).

Instead of a real increase in the petrol price of 30 %, the fuel+ package assumes an increase of 80 %.

5. ESTIMATED EFFECTS

5.1 Effects on total mobility

The estimates made with the National Model System for the TSP-2 scenarios provide clear insight into the effect of the different packages of policy measures relative to the Unchanged Policy. Of course, the estimates arẽ less realistic as far as absolute mobility levels in 2010 are concerned. These levels are affected to a significant degree by a range of exogenous developments in addition to operational characteristics of measures. Therefore, only indices will be provided.

The TSP-2 base package has achieved a substantial reduction in total personal mobility (all modes) relative to Unchanged Policy: the total growth index amounts to 127 instead of 131 for the year 2010. Car use greatly decreases in comparison under Unchanged Policy (from 170 to 147), while the other modes show increases to a greater or lesser extent. The extra policy packages (toll+ and fuel+) result in sharper reduction in car kilometres as can be seen in Table 1.

Table 1
Growth indices passenger kilometres
(average working day 2010, 1986=100)

	Unchanged policy	TSP-2 base	TSP-2 toll+	TSP-2 fuel+
Car driver	170	147	133	130
Car passenger	85	95	97	102
Train	109	139	140	143
Other Public Transport	94	117	120	123
Bicycle and Pedestrian	89	97	99	102
TOTAL	131	127	121	120

The other modes benefit from this reduction in car kilometrage, but changes are small compared with the base package.

It must be emphasised here that the growth figures presented are national averages, the growth greatly differs according to location, purpose and time of day. This is mostly a consequence of specific measures.

A good example in this regard is given by the growth figures for the 'other public transport'. These national figures obviously lag behind as compared to the growth of the train. However, further analysis shows that there is a very strong increase of travellers kilometrage for 'other public transport' from and to the four large cities (index 188), whereas public transport in other areas hardly grows at all. This strong increase is a result of the fact that most of the improvements in travel time ratio between public transport and car can be found in the Randstad area (see also Vrolijk et al, 1991).

5.2. Are the targets reached ?

Estimates with the TSP-2 base-package show that the level of congestion on the main trunk road network can be reduced to about 50% of the present (1986) level. Although the base-package shows a reasonable contribution to the reduction of the level of congestion, the "extra" policy-package "toll+" will be needed to reach a substantial reduction. In this case the level of congestion (number of waiting hours) reaches below 25% of the present level.

Expressed as waiting time per kilometer driven, this "extra" policy-package results in a level that is less than 10% of the present level. In such a situation the level of congestion on the hinterland links is lower than on the rest of the trunk road network, which was one of the targets set.

With the "base" package both the CO_2- en het NO_x-target are not reached, taking into account the reduction in truck and car kilometrage, autonomous improvement in fuel efficiency and full success at the reduction of emission at the source. However, the targets are reasonable close and can be reached with the "extra" policy-packages.

5.3. What part is played by the public transport measures.

About 80% of the reduction in car kilometrage is a result of so-called "push" measures in the car system and about 20% results from specific public transport improvements. As mentioned above, the contribution of the publlic transport measures is much higher in the Randstad area. About two-thirds of the reduction in car kilometrage "evaporates", as a result of fewer and shorter car trips. About one-third of the reduction consists of transfer to other modes. About one half of this as a tranfer to public transport.

The figures show, that the public transport improvements play only a very modest part with regard to reaching the targets on national level. It is not surprising that these figures were a disappointment to many policymakers. They had expected a much stronger national effect of the many policy measures related to improvement of the public transport system. Such expectations are often based on the misleading assumption that the car and public transport are interdependent.

It must be stated, however, that the absolute public transport figures may be somewhat higher as a result of more recent figures about exogenous developments, than the ones that were used (especialy higher forecast for population growth) and due to the fact that the estimates do not take into account the effects of:

- the 'Students PT card': since 1991 students in the Netherlands have full public transport passes provided, with the cost 'stopped at source' from their grants.
- the 'Military PT card': the same kind of card, but for military service personel.
- strong increase in the level of comfort (e.g. seating capacity). The public transport companies expect a large increase in patronage as a result of such measures, that do not play any part in the estimates. It can be questioned whether such improvements will result in a decrease of the car kilometrage, as also the car system will also meet with strong improvements of comfort in future years (more comfort, electronic support systems).
- The developments in public transport patronage over the recent years show especially with the Dutch Railways, that increased marketing efforts result in increased patronage by new market segments. A decrease in car kilometrage will only be achieved, when such marketing efforts are aimed at the present (and future) car user.

5.4. Why are car and public transport not interdependent ?

It is surprising to see that very often the assumption is made as if the car and public transport are interdependent. However, that image is very misleading. There are big differences between car and public transport both with respect to availability and comfort in use. These differences make that car and public transport constitute only partially overlapping segments of the total travel demand market.

There is, for instance, the difference in availability by time (public transport usually only operates during a limited part of the day). There is the difference in availability in space (relatively dense public transport networks in major cities, but inadequate systems in rural areas and between smaller towns and villages). Furthermore there is a difference with respect to travel purpose (need to take luggage). There is also a difference with respect to individual characteristics of the travellers too (a driving license is needed to be able to use a car independently).

All these and other differences cause car and public transport not to be interdepent. There are a lot of other alternatives for the car to choose from. For instance, over shorter distances the bicycle is a good alternative. Often with an even higher availability with respect to time and place than the car. Also the activity pattern can be adjusted; trips can be made less frequent or a destination closer to the origin can be chosen.

Besides this, the effect of changing travel costs on mode choice is limited. The cross elasticities in the model (corroborated by much examined evidence) are very low. Travel time and availability are much more important and those are not influenced by changes in costs. When the variable costs for car use and the public transport fares change, no real differences between the alternatives are introduced (see also Bovy et al, 1991).

Given all alternatives to the use of the private car it is still possible that at certain times and places, for some travel purposes, for some individuals, and under certain circumstances public transport is indeed an attractive alternative. If and when this is the case then there is a clear case of interdependency. Although such spatial relations are still a minority, the modal share for public transport can easily reach over 50% for such relations.

These situations show that a substantial transition from car to public transport can be expected in specific locations or corridors with an adequate public transport supply (see e.g. Baanders, 1991). The effectivity of public transport 'pull' measures on car use can be increased by preferably applying them in spatial relations with high travel demand where the current competitiveness of public transport is still weak. 'Push' measures lead to substitution of car travel demand in situations where public transport is competitive; furthermore, both there and in other situations, they result anyhow in a decrease in car use.

In such situations a specially adapted public transport system will be indispensable. If a switch to public transport is the aim, the public transport improvements should be mainly directed towards the circumstances of the (future) car owner. Such an approach requires public transport designed according to new design principles, with more attention paid to specific elements which are perhaps less relevant for the present (largely captive) public transport users.

6 CONCLUSIONS

From an expectation of growth in car-kilometrage to a level of over 70 % over 1986, the base package TSP-2 and its operational measures, can bring down growth to a level of 47 % according to our calculations. By 'sharpening' restraint policies, a growth index of 135, as targetted,, seems to be possible. The accessibility and environmental targets come into sight with the base package, but will not be reached. With 'sharper' policy packages these targets could prove attainable. These global results vary greatly according to location, purpose and time of day.

The reduction effect obtained is almost entirely due to the three instruments directly imposed upon car drivers (parking restrictions, fuel price raise, toll charges). On specific origin-destination relations, a substantial transfer from car to public transport can be expected. However, at a national level these (very local) effects have hardly any impact.

The explanation for the low degree of substitution at the national level can essentially be credited to one common cause, i.e.: public transport constitutes, according to location, time and character, an insufficiently attractive alternative, especially given the many other behavioural opportunities that car drivers have.

If substitution of travel demand between car and public transport is to be the main objective of improvements in the public transport system, these should be aimed at (future) car users. Such an approach asks for public transport systems according to new design principles, with specific emphasis on elements which are perhaps less relevant to the present (captive) public transport user.

ACKNOWLEDGEMENTS

We wish to express our gratitude to A.I.J.M. van der Hoorn, P.H.L. Bovy, H.F. Gunn, A.J. Daly and G.J. Hungerink. Together they paved the way to the work described in this paper.

BIBLIOGRAPHY

AVV. TSP-2 policy in figures. Rotterdam: Adviesdiensten Verkeer en Vervoer, Ministerie van Verkeer en Waterstaat, 1990. (in Dutch).

Baanders, A.. Rol en mogelijkheden van het openbaar vervoer. Bijdrage discussiedag 'Openbaar vervoer - Collectief personenvervoer. Amsterdam 1991. (in Dutch).

Bovy, P.H.L., J. van der Waard and A. Baanders. Substitution of travel demand between car and public transport: a discussion of possibilities. Paper presented at PTRC Summer Annual Meeting, University of Brighton. 1991.

Daly A.J. and H.F. Gunn. Cost-effective methods for national-level demand forecasting. Paper presented to Conference on behavioural research for transport policy, Noordwijk. 1985.

Daly A.J., H.F. Gunn, G. Hungerink and P.C. Vrolijk. Applications of the Netherlands National Model to Support Investigations of Transport Policy. Paper presented at PTRC 16th Summer Annual Meeting, University of Bath. 1988.

Holtgrefe A.A.I. Stagnation and public tranport in the Netherlands: Demand, Cost, Supply and planning. In: G.R.M. Jansen, P. Nijkamp and C.J. Ruijgrok (red) Transportation and Mobility in an Era of Transition. Amsterdam. 1985.

Ministry of Transport and Public Works. Second Transport Structure Plan. Part D: Government Decision. The Hague: SDU Uitgeverij, 1990.

Vrolijk, P.C., J. van der Waard and P.H. Mijjer, Fine tuning transport policies. Paper presented at PTRC Summer Annual Meeting, University of Brighton. 1991.