Financially independent public transport; its impacts on the public transport system in the Netherlands

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The paper deals with the question of how suspension of the subsidies for public transport operations in the Netherlands would affect the public transport system. Today, the costs of public transport far exceed the revenues, particularly in urban and regional transport. The most efficient measures for improving the financial performance are reducing the wages and increasing vehicle speed, for instance by enlarging stop spacing. In order to find the effects of suspension of the subsidies, two scenarios are developed describing opposite extremes that define probable developments in Dutch public transport. In both scenarios, suspension of subsidies would have strong negative effects on the urban and regional transport supply. The level of service would decline and fares would increase substantially. As a consequence the demand would fall. Long distance transport might be less affected. The effects might even be positive, depending on the strategy of the operators.

Keywords: cost structure, public transport, scenario analysis, subsidy, travel demand

1. Introduction

1.1 Background

In many countries in Europe, public transport got into financial troubles during the second half of the 20th century. While ownership and use of the car exploded, public transport patronage remained rather stable. However, the labour costs in public transport grew strongly, causing operational deficits. In the Netherlands, public transport has operated with deficits since the sixties. The deficits are covered by subsidies of the government.

The original motive for the Dutch subsidies was to preserve the social function of public transport, that is: offering transport to people unable or unwilling to use a car. As a result of increasing awareness of environmental burdens caused by growing car use and increasing costs of road congestion in the eighties, a new motive for subsidies was added, namely reducing (the growth of) car use. However, with the increasing level of subsidies approaching two billion Dutch guilders per year in the late eighties – 0.3-0.4% of the GNP – doubts about the effectiveness of such high subsidies were raised. To get a better insight into the function of the subsidies, the Dutch government commissioned a research project to find out what would happen if the subsidies on public transport operation were suspended. This study is reported by Peeters et al. (2000) and, into more detail, by van Goeverden et al. (2000), Bruinsma et al. (2000) and Claassen et al. (2000), who report the effects on the public transport system, the economic effects and the social effects respectively. It is important to stress that the current governmental policy is directed at improving efficiency and reducing subsidies, not suspending them (see for instance the Dutch Mobility Plan, "Nota Mobiliteit", describing the main issues of the intended national transport policy for the next 15 years).

This article gives an overview of the main results of the study as far as they relate to the public transport system. Therefore, it addresses the research question what the effects would be of suspending the subsidies for public transport operation on the public transport system, on both the supply and the demand side. Although the study relates to the Netherlands, its results will have a wider applicability.

1.2 Study design

Our study design includes three main stages. The first is an analysis of the financial performance of the current public transport systems. To that end, the public transport services are subdivided into eight subsystems being homogeneous with respect to level of service and cost structure. For each subsystem the factors responsible for the financial deficits are identified which gives a better understanding about how the financial performance could be improved.

The second stage includes an analysis of the impacts of some promising measures to performance improvement. A tool is developed enabling for a certain public transport system to evaluate the impacts of the measures on the costs and also – if the level of service or the fares are affected – the impacts on travel demand.

The third stage investigates the effects of suspension of the public transport subsidies by adopting a scenario analysis. Two scenarios were developed for the hypothetical future situation that no subsidies are granted to public transport operators. They describe two opposite extremes defining the probable developments at the demand and supply sides of public transport. The scenarios are evaluated by means of the above-mentioned tool and compared to the current situation. Additionally, the demand in each scenario is compared to the estimated demand in a trend scenario describing the expected developments if the subsidies are continued. So, the scenario analysis involves four cases to be compared with respect to travel demand, and three cases with respect to other variables.

2. The current situation

2.1 Years representing the current situation

The analysis of the current situation intends to provide insights into promising measures that may improve the financial performance of public transport. For reasons of data availability, the year 1990 is defined as the ‘current’ situation. The choice of this somewhat dated year will have no serious consequences for factors that are rather constant in time, like the cost structures of public transport systems. However, there is one factor that changed dramatically the demand for public transport shortly after 1990. In 1991 a travel pass was introduced enabling Dutch students on colleges and universities to travel free on all regular public transport services in the Netherlands which caused a substantial increase in public transport demand, in particular for train travel. Therefore, we selected a more recent year (1998) to represent the current travel demand volumes. Summarizing: financial data are based on 1990, whereas transport demand volumes are based on 1998.

The following sections describe the financial performance and cost structures of the current public transport systems, their levels of service and the demand for these systems. The cost analysis is restricted to the operational costs. Infrastructure costs are excluded.

2.2 Financial performance

Table 1 gives an overview of the financial performances in 1990 of the eight defined public transport systems. The figures are based on the “Vademecum personenvervoer”, published by the Dutch Ministry of Transport, on statistics of passenger transport, provided by the Dutch Central Bureau of Statistics (CBS) and on annual reports of public transport companies.

Table 1. The financial performance of Dutch public transport in 1990

	Total amounts (mln Euro)		Figures per person km (Eurocent)		Revenue-cost ratio	Average occupancy
	Costs	**Revenues**	**Costs**	**Revenues**		
Urban bus	309	78	34.9		0.25	0.14
Urban tram	171	47	32.0	8.8	0.28	0.13
Underground	88	44	17.6		0.50	0.14
Regional bus	524	196	17.2	6.4	0.37	0.14
Local train in rural areas[1]	68	26	14.8		0.38	0.22
Local train in non-rural areas[2]	348	230	8.6	5.7	0.66	0.30
Express train	323	351	5.2		1.09	0.39
High-speed train	*	*	*	*	*	*
Total public transport	1831	972	11.7	6.2	0.53	0.23

*: not in operation in 1990; [1]: diesel-electric train; [2]: electric train

For the whole public transport system about half of the operating costs are covered by the revenues. The revenue/cost ratios vary strongly across the systems. It is lowest for urban transport on street level (25 to 30%), followed by regional bus transport and trains in rural areas (35 to 40%). The revenues of the underground system meet half of the costs while those of the local electric train services cover two thirds of these. The express train system is the only system whose revenues exceed the operating costs.

Regarding the seemingly low average occupancies it has to be noted that the occupancy is directly related to the definition of the vehicle capacities. The capacities of bus, tram and underground lying behind the figures of Table 1 include standing places, assuming high standing capacities of 4 to 4.5 persons per square meter. Assuming more comfortable, lower standing capacities would raise the occupancy values. The train capacities are set equal to the number of seats, as is usual.

Generally the revenue/cost ratio increases when one moves down the table to higher level systems. This gives rise to the hypothesis that this ratio is influenced by at least one of three factors that also generally increase moving down the table, which are: occupancy, operating speed, and vehicle capacity[1]. Each of these factors can be argued to have a positive influence on the benefit-cost ratio.

The influence of the average occupancy is clear since the revenues are proportional to the occupancy, while there is only a very small (positive) relation between the occupancy and costs. The possibilities for raising the occupancies are limited, however. The problem is that on the one hand travel demand is very unequally distributed over space and time, leading to a maximum load that is much higher than the average occupancy and should not be increased any more, while on the other hand the operators aim at offering a regular service with a rather even quality over time.

[1] The term "vehicle" relates in the paper to the complete moving units and includes trains for instance.

Increasing the average operating speed leads to a more efficient utilization of vehicles and personnel, resulting in lower costs for vehicles and vehicle crew. As can be seen in Table 2, based on the same sources as Table 1, these cost factors are very important. In all systems the costs of the vehicle crew account for a substantial portion of total costs – even more than 50% in the bus systems – while especially for the rail systems the costs of fleet ownership are also high. Therefore, increasing the operating speed is a promising strategy in cost reduction.

Table 2. Cost components of Dutch public transport in 1990

	Fleet ownership (%)	Vehicle maintenance (%)	Vehicle crew (%)	Station staff (%)	Overhead (%)	Energy (%)
Urban bus	11	12	57	0	14	6
Urban tram	32	16	35	0	10	7
Underground	36	14	20	14	10	6
Regional bus	14	8	55	0	13	9
Local train in rural areas	23	9	29	17	15	7
Local train in non-rural areas	25	12	25	12	13	13
Express train	21	15	28	14	15	6
High-speed train[1]	34	21	15	4	10	17
Total public transport	20	12	40	6	13	9

[1]: estimated cost structure in 2010

Finally, increasing vehicle capacity may raise the revenue-cost ratio. The contribution of vehicle capacity comes up in the context of a growing demand, where the operator deploys larger vehicles in order to accommodate the larger passenger number. Assuming that a constant maximum load (degree of occupancy) is leading in vehicle employment, increasing vehicle capacity may reduce the costs while also an increase of the revenues can be argued. Cost reduction will be achieved by economies of scale. Revenues may be affected positively by a small increase of the average occupancy. The reason is that the relative fluctuations around the expected number of passengers using a certain service become smaller when the expected passenger number increases. The share in the vehicle capacity of the additional capacity offered to accommodate possible passenger numbers that exceed the average becomes smaller.

2.3 Level of service

Table 3 gives an overview of the level of service of the defined public transport systems in 1990. The level of service is characterized by the average access and egress distance to the stops or stations, average frequency of the services, and average operating speed of the vehicles. The average access and egress distances relate to the whole population and are larger than the actual distances travelled by public transport users. Note that the urban bus and tram systems are complementary on the same hierarchical level, which means that the urban access and egress distances on this level should be those of the combined system. There are no national figures for the latter, but they will be probably similar to (and a little smaller than) the access and egress distances for the urban bus.

The access end egress distances are roughly estimated, not having detailed GIS-maps available that would be needed for an accurate assessment. The values of the other variables are based on timetables and statistics provided by CBS and public transport companies. Because the variables differ greatly between urbanized and non-urbanized areas, they are reported separately for both area types if a system serves both.

Table 3. Level of service of the Dutch public transport systems in 1990

		Access and egress distance (km)	Frequency (services per hour)			Operating speed (km/h)
			Daytime	Peak	Evening, Sunday	
Urban bus		0.33	4	7.5	2.5	23
Urban tram		0.96	10	14	6.5	18
Underground		2.6	10	12	8.0	35
Regional bus		0.74	2	3.6	1.0	38
Local train in rural areas		12.0	1.5	1.8	1.0	69
Local train in non-rural areas	1	5.7	4	5.5	3.5	65
	2	12.5	1.8	2.2	1.5	83
Express train	1	13.8	3.5	3.6	3.3	93
	2	32.0	1.9	2.2	1.5	97

1: urbanized areas, especially the Randstad region; 2: non-urbanized areas

The figures demonstrate that the values of the variables vary greatly over the systems and, in the case of frequency, over the time periods of the day. Generally, in urbanized areas the access and egress distances are relatively small, the frequencies are high while the vehicle speeds are low.

2.4 Demand

Demand volumes are calculated using databases of the Dutch national travel survey (OVG). Because the OVG surveys overestimate public transport ridership somewhat, its figures are corrected based on a comparison of the OVG output and transport statistics of the public transport companies. In 1998, the year chosen as the base situation regarding public transport demand, 800 mln trips were made by public transport in the Netherlands, accounting for 4.8% of all trips. The number of passenger kilometres was 20 billion, 11.4% of all person kilometres in the Netherlands. Table 4 shows the passenger kilometres for the defined public transport systems, both for 1990, the main base year of the analysis, and 1998, the base year for the travel demand.

Table 4. Demand for the Dutch public transport systems (mln passenger km)

	Demand in 1990	Demand in 1998	1998/1990 Demand ratio
Urban bus	885	840	0.95
Urban tram	534	570	1.07
Underground	500	695	1.39
Regional bus	3041	3038	1.00
Local train in rural areas	459	564	1.23
Local train in non-rural areas	4011	4920	1.23
Express train	6237	9450	1.52
Total public transport	15700	20100	1.28

The table demonstrates the large increase in public transport demand after 1990, mainly due to the introduction of the student pass. Additionally, the increase in use of the underground can be explained to a large extent by the extensions of the underground networks of Rotterdam and Amsterdam. From 1998 onwards, public transport demand is rather stable.

The demand fluctuates a lot both over time and space. Figure 1 illustrates the fluctuation over time. The figure shows the distribution of the number of people that travel by public transport over a 24 hour period. In fact, the fluctuation is larger than indicated in the graph, because the demand is unequally distributed over the two travel directions. This is especially true for the high morning peak.

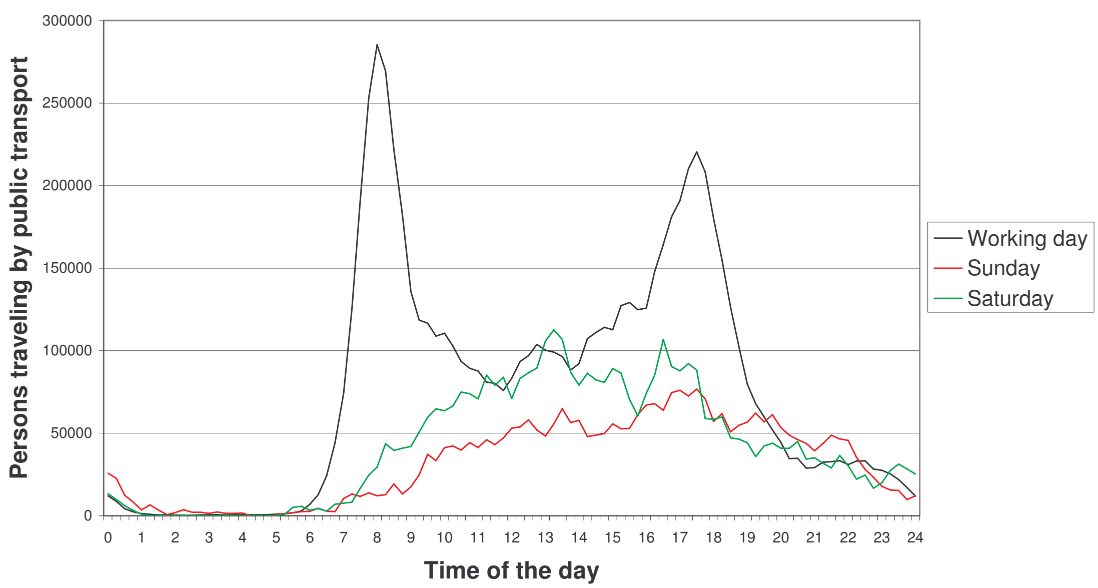

Figure 1. Temporal distribution of Dutch public transport ridership in 1998

The degree of fluctuation is highest in regional transport and smallest in long distance transport. Interestingly, the distribution of travellers of all modes, travelling at least 2 km, varies less than the distribution of only public-transport users. This is also true for the different travel markets separately: the urban, regional and long distance markets. Therefore, measures that are directed to a large increase of the share of public transport may result in a more uniform distribution, so raising the average occupancies.

3. The effects of some measures on costs and demand

We will now analyse the effects of some promising measures to improve the financial performance of public transport. First the tool used for the analysis is described.

3.1 The tool

For the impact analysis a model system is adopted consisting of two extant tools. One is the so-called "Bouwdoos Vervoersystemen" (box of building blocks for transportation systems) developed by the TU Delft (Egeter *et al.*, 1995). This tool is a kind of model enabling the user to synthesize a transportation system by defining generic characteristics of the vehicles, infrastructures, services, and network of a system, as well as characteristics of the general environment (like population density and energy prices) and the demand for the system. This model facilitates evaluating the system with respect to impacts on the travellers (level of service), impacts on the operator (costs), and impacts on the environment (for instance noise and pollution).

The other tool is the so-called "Scenarioverkenner" (Scenario Explorer) developed by TNO-Inro (Heyma *et al.*, 1999). This is a travel demand model that estimates future travel demand in the Netherlands by mode, trip purpose, and relation type for given scenarios. The relation types are defined by combining the origin and destination area types. The model distinguishes six area types differing with respect to degree of urbanization and function (for instance central area versus commuter area). The scenarios are defined both by factors outside the transportation system (demographic, economic, social and spatial factors) and factors inside the system (technological factors, level of service of the different modes, prices and regulations).

Both tools are combined into a single model system. The procedure in using the model system is first to synthesize the defined public transport systems in the "Bouwdoos" for a certain year or scenario on the basis of which the "Bouwdoos" calculates the variables that indicate the level of service of each system. Secondly, these level of service indicators are entered into the Scenario Explorer calculating the travel demand per system. Finally, the travel demand for each system is entered back into the "Bouwdoos" for calculating the costs, vehicle occupancies, and environmental impacts. The latter are not relevant for achieving good financial performance and play only a minor role in the study.

3.2 The effects of measures

By means of the model system described above, the expected effects are calculated for measures that are intended to decrease the costs or increase the revenues.

Section 2, dealing with the current situation, gave some idea about promising measures for cost reduction, in particular measures that may reduce vehicle costs and measures that may reduce personnel costs. These measures can affect the costs directly by lowering the unit costs or indirectly by a more efficient employment of vehicles and personnel. The most promising way to achieve the latter is increasing the operating vehicle speed. The following cost-reducing measures are analysed:

1. Reduce fleet ownership costs by 50%. These costs include both amortisation and interest payments.
2. Reduce wages by 50%.
3. Double the speed characteristics of the vehicles (maximum speed and acceleration for speed up and slow down) and halve the average stopping time.
4. Double the distance between successive stops or stations, assuming that this has no effect on the average operating cost of a station.

Table 5 shows the effects on the costs per seat kilometre of the described measures. For the measures that affect the costs by increasing the operational speed, also the impact on the speed is displayed. The figures are index numbers, where the situation without any measure is the reference.

Table 5. Effects of some measures on public transport costs (no measure = 100)

Measure		**(1) Halve fleet costs**	**(2) Halve wages**	**(3) Double vehicle speed**		**(4) Double stop distance**	
Affected variable		**Cost/ seat km**	**Cost/ seat km**	**Cost/ seat km**	**Operat. speed**	**Cost/ seat km**	**Operat. speed**
Urban bus		94	60	84	160	77	135
Urban tram		84	72	89	165	74	142
Underground		82	73	92	166	77	125
Regional bus		93	63	89	161	77	135
Local train in rural areas		89	67	97	154	73	129
Local train in non-rural areas	1	87	73	127	148	71	137
	2	89	68	103	161	76	124
Express train	1	89	66	90	172	82	119
	2	88	68	89	176	82	115
High-speed train		83	79	120	151	81	129

1: urbanized areas; 2: non-urbanized areas

The table demonstrates that reducing wages is the most effective measure. This result is in line with the observed substantial decrease in hourly wages of British bus drivers after privatisation and deregulation of the UK bus market, going together with a clear increase in the general wage level (Matthews et al., 2001). Second best in the table is increasing stop distance or distance between stations. Other measures that increase the operating speed, like influencing traffic lights by public transport vehicles or building bus lanes (not shown in the table), will have similar effects. It is remarkable that increasing the speed characteristics of the vehicles has only small and sometimes even reverse effects. This reflects the balance of lower costs due to a more efficient employment of vehicles and staff and substantially higher energy costs.

The revenues can be increased by measures that affect one of the two components of this variable, namely the demand volume and the fares. Because changing the fares also

influences demand, measures that affect the revenues always affect demand. Therefore, the analysis of measures to increase the revenues concerns the effects on demand. They include both measures that affect the level of service (indicated by the same variables as in Table 3) and raising the fares. The following demand-influencing measures are analysed:
1. Reduce the frequency by 50%.
2. Double the frequency.
3. Increase the operating speed of all public transport systems by 50%.
4. Increase the access and egress distances of the bus and tram systems by 50%.
5. Double the fares in all public transport systems.

Regarding the frequency, both a decrease and an increase are evaluated. The rationale of the first is reducing the costs while that of the latter is raising the demand and the revenues. Because the effects of frequency adaptation depend on the initial frequency, the effects are calculated both at a high initial frequency and at a low initial frequency. Table 6 shows the calculated effects.

Table 6. Effects of some measures on public transport demand (no measure = 100)

Measure		**(1) Halve frequency**		**(2) Double frequency**		**(3) Increase speed**	**(4) Decrease stop density**	**(5) Double the fares**
Initial frequency		**High**	**Low**	**High**	**Low**			
Urban bus		86	81	108	114	106	91	72
Urban tram		91	87	105	107	104	93	77
Underground		91	88	105	107	105	92	74
Regional bus		84	82	111	117	131	85	62
Local train in rural areas		69	67	126	133	132	86	52
Local train in non-rural areas	1	85	80	109	113	134	88	52
	2	69	69	124	126	134	86	50
Express train	1	78	74	114	117	136	87	45
	2	68	62	124	133	133	86	49
High-speed train		76	76	115	115	136	87	45
Total public transport		77	74	116	121	131	87	52

1: urbanized areas; 2: non-urbanized areas

A general conclusion from the table is that urban transport demand is less sensitive to changes in the level of service or the fares than demand for regional or long distance transport. This means that, in the urban market, measures directed to cost reduction as well as raising fares are relatively effective with respect to increasing the revenues. In the non-urban transport markets, measures that are directed to attract more passengers are relatively effective.

Summarizing, the most effective measures improving the financial performance are reducing wages and increasing the operational speed, without altering the current speed characteristics of the vehicles. The latter contributes in two respects to a better financial performance: it reduces the costs of vehicles and staff, and it attracts more passengers, so raising the revenues. Increasing the speeds by enlarging the average stop distance has also a reverse effect. It reduces demand because the average access and egress distances increase. The balance of the two effects depends on the degree to which both the operational speed and the access and egress distances increase which is related to the initial stop distance. The model system calculates that doubling the current stop distances of the Dutch bus and tram systems will increase total demand. The same result is reported by Van Nes (2000) for the urban bus and tram systems.

4. Effects of suspension of public transport subsidies

Let us now discuss the effects of suspension of the subsidies on the supply and demand sides of the public transport system. Effects outside the public transport system are not the intent of this article. They are discussed in Dutch in the project reports, summarized by Peeters et al. (2000). An overview of these effects in English is given by van Goeverden et al. (2004).

Most of the effects are estimated by means of a scenario analysis. This section first describes the scenario development and then discusses the estimated effects.

4.1 Scenario development

General starting points
Two scenarios are developed for 2010 based on the Trend scenario defined in the Scenario Explorer. Only the designs of the public transport systems in the two scenarios differ from that in the Trend scenario. Regarding the public transport design, the starting point of the scenario development is that a) the subsidies for public transport operation are suspended and b) the train operators have to pay an annual levy of €136 mln (1990 price level) for utilization of the Dutch railway infrastructure. In 1990, the base year of the study, there was not yet a levy for railway use. It is assumed that the financial support will be reduced gradually from the year 2000 on and will be suspended in 2008, two years before the scenario year. Fluctuations in the demand that may be caused by the changes in the supply of public transport will then have faded away.

As noted in section 1, the two scenarios give bounds on the probable development of public transport supply and demand. The main difference between the scenarios is the basic attitude of the public transport operators that determines their main strategy for eliminating the deficits.

In the first scenario, the strategy of the operators is primarily focused on satisfying the investors by aiming at a high profit. This leads to an emphasis on cost reduction. The new independence of governmental rules that were connected with granting subsidies is used to cut the most uneconomic services without considering the social and community interests. This is the so-called ‘Yield scenario’.

In the second scenario, the operators want to increase their market share. The strategy is primarily directed at attracting more customers and thus increasing the revenues. Therefore, they take measures that raise the level of service. The operators do not aim at a profit. They are satisfied if the revenues cover the costs. This is the so-called ‘User scenario’.

The following assumptions have been chosen in developing the scenarios:

1. The rule that the revenues at least outweigh the operating costs holds for the three main sub markets separately: urban, regional and long-distance transport. Within a sub market cross subsidy between public transport systems is allowed.
2. The government retains the ability to invest in new public transport infrastructure without asking a financial contribution for this from the transport companies.
3. New infrastructure projects that have already been started will be finished according to the plans; the main projects are investments in the underground systems of Amsterdam and Rotterdam and high-speed rail lines.
4. Reduction of the wages of public transport employees will not exceed 10%, due to social and union activities.
5. Paratransit is left out of the analysis. Therefore, the study will not be able to consider possible shifts from regular transit to paratransit.

In the Yield scenario, the government does not play any role, other than regulating and enforcing safety and environmental laws. In the User scenario the government supports the strategy of the operators to make public transport more attractive by investing in infrastructure. In exchange she retains some regulatory power with respect to the levels of service and fares.

Development of the scenarios

The scenarios are developed and evaluated stepwise. First, base variants of both scenarios are defined in accordance with the strategies. Finding that public transport is still not self-supporting, the base variants are adapted and evaluated in an iterative process until a situation is found without operating losses. In developing the base variants some measures are scenario independent, others are scenario-specific. At first the fares are left unchanged. This gives insight into the possibilities for reducing the deficits at the current fare level.

The scenario independent measures are cost reducing measures that do not affect the overall level of service and the revenues negatively. These measures relate to more efficient employment of vehicles and staff – in particular in urban and regional transport – and to a reduction of the unit costs of vehicles and staff. They include replacing the trams and rural trains by lighter and cheaper ones, enlarging stop distances in the bus and tram systems, and straightening the urban and regional bus lines. It is true that the two latter measures cause higher access and egress distances contributing negatively to the level of service, but they also contribute to it positively because of the higher speed. As stated in section 3.2, the balance of both is positive. Wage reduction, the most efficient measure according to section 4, is not included. It is assumed that this measure requires agreement from the labour unions, which can only be realized if the other measures clearly fail.

In the User scenario, the scenario-specific measures focus on increasing the demand and revenues. The period of operation is extended to the early hours of the night, new stations are opened in large urban areas, and the frequencies of the services are raised. If this strategy is successful and leads to a substantial increase in demand, it is likely that the distribution of the public transport demand over the hours of the day will become more like the more equal distribution of all modes. This implies a relatively large increase in the off-peak and a more efficient employment of vehicles and staff.

In the Yield scenario, the scenario specific measures result in cancelling the most uneconomic services. The periods of operation are shortened, the operation of many urban and regional bus lines is terminated, some regional train stations are closed and frequencies are reduced.

Evaluating the two base variants makes clear that the cost-effectiveness of both scenarios increase accompanied by a large increase of demand for public transport in the User scenario and a large decrease in demand in the Yield scenario. Most interesting is that in the User scenario the demand grows by 40%, without increasing the deficit. However, in the base variants of both scenarios a large gap still exists between revenues and costs, especially in the urban and regional systems. Therefore, new variants of the scenarios have to be developed.

The adaptations of the base variants are strictly directed at improving the revenue/cost ratios and are sometimes contrary to the strategy of a scenario. The measures are lowering the wages (by the maximum allowable amount of 10%), raising the fares, and reducing the capacity supplied by closing lines, reducing frequencies or shortening trains. The capacity reduction is needed to maintain a reasonable occupancy after the fall in demand that is induced by the higher fares and by some of the capacity reduction measures themselves. After an iterative process of adapting the scenario-variants, final variants of both scenarios are developed that meet the requirements that public transport is self-supporting (User scenario) or even gains a reasonable profit (Yield scenario).

4.2 The estimated effects

The effects on the public transport system are estimated using the tool described in section 3.1. Next we will first give an overview of the financial performance of the public transport systems in the final variants of the two scenarios and then describe the changes in the level of service and the resulting changes in travel demand.

Financial performance
Table 7 demonstrates the improved financial performance of public transport in the two scenarios. It shows the revenue-cost ratios and the changes in costs per person km, revenues per person km and average occupancy. The latter three variables are represented by index numbers, with the 1990 situation as the reference. The index numbers concerning costs and revenues exclude inflation. The User and Yield scenarios are indicated by “US” and “YS” respectively.

Table 7. The financial performance of public transport in the scenarios (2010)

	Revenue-cost ratio		Costs/ person km (1990 = 100)		Revenues/ person km (1990 = 100)		Average occupancy (1990 = 100)	
	US	YS	US	YS	US	YS	US	YS
Urban bus	0.78	0.97	65	52			96	169
Urban tram	1.07	1.17	52	47	201	199	95	158
Underground	1.32	1.33	77	76			151	169
Regional bus	0.96	1.35	68	48	173	173	116	198
Local train in rural areas	0.84	1.22	45	43			119	126
Local train in non-rural areas	0.73	1.06	89	84	100	136	113	117
Express train	1.47	1.52	75	99			140	140
High-speed train[1]	1.88	2.33	58	64			148	140
Total public transport	1.01	1.13	60	68	113	146	151	168

[1] The index numbers of the high-speed train are compared to the express train figures in 1990

In the User scenario the total revenues of the public transport operators just cover the costs, while in the Yield scenario they gain a profit of 13%. The separate systems sometimes still have deficits, especially in the User scenario. This does not necessarily conflict with the requirement that urban, regional and long distance transport each should be self-supporting. In urban transport, the deficits of the bus are fully compensated by the profits of the rail modes in both scenarios. Furthermore, long distance transport is very profitable. However, there is one market that does not quite satisfy the requirement, viz. the regional market in the User scenario. This scenario demands some cross subsidy within the train system from the profitable long distance train services to the regional train services.

The figures demonstrate the large decrease in operating costs that is realized. Only the operating costs of the express trains in the Yield scenario seem not to be affected. The reason is that the train figures reflect not only the differences in operating costs but also those in infrastructure costs. Unlike in 1990, in the scenarios the train operators have to pay a predetermined amount for use of the rail infrastructure. In the Yield scenario, where the demand for public transport and the scale of operation are relatively small, the levy on infrastructure use accounts for a substantial part of the costs.

Furthermore, the table shows that the revenues per person km increase significantly, especially in urban transport and regional bus transport. The increase reflects the rise in fares. The occupancies also increase substantially, with the vehicles becoming more crowded.

Level of service

Table 8 shows the index numbers of some variables indicating the level of service. Again, the scenario figures are compared to 1990. The frequency variable is the number of services per week, so it indicates changes in periods of operation and interval times simultaneously. The operating speed relates to the speed of the vehicles. Another variable, vehicle crowding, was indicated in Table 7 by the changes in occupancy.

Table 8. Level of service impacts of two scenarios (1990 = 100)

	Frequency		Access/egress distance		Operating speed	
	US	YS	US	YS	US	YS
Urban bus	119	48	202	245	139	101
Urban tram	61	28	108	133	147	94
Underground	71	42	71	74	100	100
Regional bus	95	42	156	236	123	110
Local train in rural areas	127	61	98	149	110	124
Local train in non-rural areas	136	65	100	157	96	103
Express train	107	51	99	103	108	101
High-speed train[1]	144	90	418	424	177	165

[1] Compared to the express train figures in 1990

In the Yield scenario a large overall decline of the level of service will result from the measures. Frequencies fall, and bus and tram stops as well as the regional railway stations are at much larger distances. Only the access distance to the underground system in the largest cities decreases. Other positive changes are the moderate speed increases of some systems, and the introduction of the high-speed train.

The results for the User scenario are less detrimental. It is true, that in urban transport the access distance to the bus stops greatly increases and that the frequencies on the urban rail transport decrease, but there is a substantial increase in speed of the bus and tram systems. In regional bus transport again a larger access distance to the stops is accompanied by a higher operating speed. The frequencies decrease a little. The most positive findings relate to the train systems. The level of service rises, mainly due to a substantial increase of the frequencies and the introduction of the high-speed train.

Demand

Table 9 indicates the development of the demand for public transport. The table shows figures for three scenarios: the User and Yield scenarios and the Trend scenario that is defined in the Scenario Explorer. The latter is based on the expected developments in public transport without suspension of the subsidies and without increase of the real fares.

Table 9. Estimated demand for public transport (1998 = 100)

	User scenario	Yield scenario	Trend scenario
Urban bus	64	38	93
Urban tram	55	37	89
Underground	90	66	154
Regional bus	68	38	92
Local train in rural areas	109	47	110
Local train in non-rural areas	105	51	107
Express train	91	33	85
High-speed train[1]	44	23	46
Total public transport	110	51	117

[1] Compared to the express train figures in 1998. There was no high speed service in the Netherlands at that time; the high speed trains starting in 1996 and running to Paris did not run at high speed on Dutch territory.

The figures show, that in the User scenario the overall public transport demand increases a little, but less than in the Trend scenario. The increase must be fully attributed to the increase in travel by train. It is interesting that the demand for train travel is similar to that in the Trend scenario. The demand for urban transport and regional bus transport decreases substantially. The demand for these systems is also much smaller than in the Trend scenario.

In the Yield scenario the overall demand falls by 50% and large decreases occur for every system. Even the introduction of the high-speed train does not prevent the demand for long distance trains being severely cut. The decrease in urban and regional transport is much larger than in the User scenario.

5. Conclusion

The financial problems in public transport are concentrated in urban and regional transport. The operating costs far exceed the revenues, with some systems having a revenue/cost ratio of less than 50%. On the other hand, long distance transport is still profitable. One of the reasons for the bad financial performance is the unequal distribution of travel demand over time and space, which implies low average occupancies. The most efficient measures to improve the financial performance are reducing the wages (this will be difficult to implement, however) and increasing vehicle speed, for instance by increasing stop spacing.

Suspension of subsidies for public transport operation would have strong negative effects on the urban and regional transport supply. The level of service would decline and the fares would increase substantially. As a consequence demand would decrease. The decline of the level of service is the result of much lower network and stop densities, lower frequencies, and more crowded vehicles. The extent of the effects depends on the strategy of the operators for eliminating the deficits. If they focus on offering a high level of service in order to attract more customers, the estimated fall in demand is about 30%. If they focus on cost reduction and earning the highest possible profit, the demand might fall up to 60%.

The effects on long distance transport can either be negative or positive, depending on the strategy of the operators. Focusing on profits might lower the level of service seriously. The demand can fall up to 50%. On the other hand, focusing on the attractiveness of public transport might have small positive effects and result in an increase in demand that equals the estimated increase for the situation that granting of subsidies will be continued.

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References

Bruinsma, F.R., Rietveld, P. (2000). *Openbaar vervoer op eigen benen. Economische effecten. Eindrapportage*. Adviesdienst Verkeer en Vervoer, Rotterdam.

Central Bureau of Statistics, Databases Onderzoek Verplaatsingsgedrag (national travel survey), several years.

Central Bureau of Statistics, Statistiek van het personenvervoer, several years.

Claassen, A.W.M., Katteler, H.A. (2000). *Openbaar vervoer op eigen benen. Sociale effecten. Eindrapportage*. Adviesdienst Verkeer en Vervoer, Rotterdam.

Egeter, B., Binsbergen, A. van, Goeverden, C.D. van, Schoemaker, Th.J.H. (1995). *Ruimpad: Bouwdoos vervoersystemen*. TRAIL Research School, Delft.

Goeverden, C.D. van, Schoemaker, Th.J.H. (2000). *Openbaar vervoer op eigen benen. De vervoerkundige effecten van afschaffing van de exploitatiesubsidie aan openbaar-vervoerbedrijven*. TU Delft, Delft.

Goeverden, C.D. van, Peeters, P.M. (2004). Self-supporting public transport: The effects of suspension of the subsidies for public transport operation in the Netherlands. *Paper presented at the 10th WCTR 2004*, July 2004, Istanbul.

Heyma, A., Korver, W., Verroen, E.J. (1999). *De Scenarioverkenner, versie 1.2, delen 1, 2, 3 en 4*. TNO Inro, Delft.

Ministry of Transport (1995). *Vademecum personenvervoer.* Den Haag.

Ministry of Transport (2004). *Nota Mobiliteit, Naar een betrouwbare en voorspelbare bereikbaarheid*. Den Haag.

Matthews, B., Bristow, A. and Nash, C. (2001). Competitive tendering and deregulation in the British bus market - a comparison of impacts on costs and demand in London and the British Metropolitan Areas. *Paper presented at THREDBO7 2001,* Molde, Norway.

Nes, R. van (2000). *Optimal stop and line spacing for urban public transport networks, analysis of objectives and implications for planning practice*, TRAIL Research School, Delft.

Peeters, P.M., Schoemaker, Th.J.H., Goeverden, C.D. van, Rietveld, P., Bruinsma, F.R., Claassen, A.W.M., Katteler, H.A. (2000). *Openbaar vervoer op eigen benen. Tussen klant en belegger. Hoofdrapport*. Adviesdienst Verkeer en Vervoer, Rotterdam.

Annual reports of NS, GVB Amsterdam, RET and HTM (Dutch railways and public transport companies of Amsterdam, Rotterdam and The Hague).