University of Groningen

Tracking transport systems

Bouwman, Mirjan Elisabeth

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2000

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):
Bouwman, M. E. (2000). *Tracking transport systems: an environmental perspective on passenger transport modes*. s.n.

Copyright
Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license. More information can be found on the University of Groningen website: https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment.

Take-down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): http://www.rug.nl/research/portal. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Download date: 04-02-2023

Summary

Introduction

In the latter part of the 20th century awareness grew that current levels of consumption and associated impact on the environment may have irreversible long-term effects. When accepting the concept of sustainable development, i.e. development of current generations may not limit the development of future generations, current levels of consumption can be categorised as non-sustainable, and reduction of the environmental impact from consumption is required. The share of transport in the overall environmental pressure is considerable and has been increasing in the last decades, mainly due to a substantial increase in mobility. Accordingly, transport is a highly relevant subject for reduction of overall environmental pressure. A division can be made into three different ways to reduce environmental pressure associated with transport. First and most effective way is to reduce the transport volume, in which personal mobility (or freight transport volume) is reduced. Another option is to reduce the impact on the environment per travelled kilometre, i.e. to improve the efficiency of transport. This is a common option; all new technologies applied in, for example, passenger cars to reduce energy use and emissions can be categorised as reducing the impact per kilometre. The last option is to switch to alternatives with lower environmental pressure. In case of mobility, this can refer to the substitution of motorised travel by non-motorised travel, which results in a considerable energy saving. This third option of reducing environmental pressure of transport receives relatively little attention. This thesis aims at the latter and tries to identify transport modes with a favourable environmental score. For doing so, not only the environmental performance of transport modes should be taken into account, but also individual characteristics determining the service level of transport modes. Basic goal is to rank various transport modes, both taking into account the environmental performance of the mode, and its individually relevant characteristics. Such a ranking does not represent modal split choices, nor is it possible to calculated energy savings at a national level. Based on such a ranking, policies can be developed to stimulate travel into a sustainable direction.

One of the major issues that plays a part in switching to alternative transport systems is the possible contrast between the individual and collective characteristics of a transport system. Environmentally friendly transport systems do not necessarily have favourable characteristics for an individual traveller. This implies that a switch to another transport system might compromise individual interests. This observation led to the central question of this thesis: is there an optimal transport system from both an individual and societal perspective?

TCC

In order to calculate individual and societal characteristics of transport modes, an approach is developed and applied which uses elements from several common methods in environmental science. Neither one of this methods is suitable for calculating all desired characteristics. Elements of the Life Cycle Analysis, the Energy Analysis and the dynamic Life Cycle Analysis are comprised in an adjusted approach. This approach is made operational in Matlab to calculate transport characteristics. The resulting computer model is called TCC (transport characteristics calculator). The TCC calculates four characteristics of transport systems. First characteristic is the energy use, used as an indicator of environmental pressure. Of all environmentally relevant characteristics, energy use and associated CO_2 emissions seem to be of largest importance. Moreover, space use of transport systems is included in the analysis as second societal characteristic, representing another scarce good in the Netherlands. Travel time and costs are included in the model as individual characteristics, representing two important relevant characteristics when selecting transport modes. The TCC calculates these four characteristics for a variety of transport modes, where the Dutch country is used as system boundary. Outcomes are specified by urban setting and trip length, and are calculated for the period 2000 – 2025.

In order to calculate all desired characteristics, a variety of model input data is required. Values for 1996 are collected and used for base year calculations. For calculation of future characteristics scenario data are used. Four scenarios – developed by the SEP – and their effects on the mobility are calculated with the use of the Scenario Explorer.

Outcomes for 2000

The first step in answering the overall question is to determine how the various transport system score on the selected characteristics. Calculation of the characteristics for 2000 shows that soft mode travel like walking and bicycle have the most favourable energy use figures. Of the motorised transport systems, the public transport systems show a favourable energy use over the individual systems. For space use, soft modes show the highest values due to the low intensity on their infrastructure. Again, the public transport modes score favourable over the individual transport modes. For the costs, again the soft modes have an extremely good score. Walking is completely free; cycling is considerably cheaper than all motorised transport modes. In general, the use of public transport modes is cheaper than the use of private systems. Finally, travel time of systems shows that motorised transport systems are considerably faster than soft modes. Soft modes show travel times that are five to ten times as long as those of motorised systems. Travel time of train travel is slightly quicker than that of cars, while the travel time of bus, tram and metro is longer than that of passenger cars.

As none of the above mentioned modes shows favourable scores on each of the characteristics, a combination of the calculated values is required in order to present a ranking order of transport modes. For doing so, values are first scaled, equating the largest value of each characteristic on one, and than summed with an equal weight of 0.25 for each of the characteristics. The resulting value is called sssv (standard scaled summarised value). Calculating such sssv for the various transport modes results in a lowest score for the bicycle and the train. The bus, tram and metro have a slightly worse score, followed by a group with the diesel and LPG passenger car. The petrol passenger car, walking and other modes form the cluster with the worst sssv.

Average sssv are based on the average trip length per transport mode, which varies strongly among the modes. The TCC also allows calculating results for different trip lengths. In general, characteristics of transport modes improve with increasing trip length. However, the amount of improvement varies among the transport systems. The sssv of walking improves with only 6 %, while the sssv of the bus, tram and metro improves with 47 %. The change in improvement rate may cause differences in the ranking order of transport systems. When observing the sssv by trip length, the bicycle is the best system at trips shorter than 2.5 kilometre. On longer trips, the train shows a comparable score, and is better than the bicycle at distances over 20 kilometre. Walking also scores well at distances under 2.5 kilometre, and is part of a lager cluster of systems with comparable scores at longer distances. The bus, tram and metro form a good alternative for the train and bicycle at distances over 20 kilometre. The petrol passenger car always scores worse than the other two passenger cars, due to its low annual use. The LPG and diesel passenger car belong to the second cluster of transport modes at trips with a length over 20 kilometre, on a considerable distance from the train, bicycle and bus, tram and metro. Trip length influences the ranking order of the various modes. However, the changes are limited, and the overall conclusion that the bicycle and the train form the optimal system is not contradicted on any trip length. Only slight nuances to this conclusion can be made on the various trip lengths. The variation in average trip length of the various transport systems are in favour of the modes used for large distances, when only taking average values into account.

The presented ranking order of transport systems is based on the single mode use of each of the transport systems. In practice, not all modes can be used door to door, requiring the use of complementary transport systems. Moreover, not all transport systems have the same network density, which may result in different routes between two points for the various systems. The latter can be represented in the results by the introduction of route factors. Such route factors only influence the ranking order on very short distances, where the score of the public transport systems worsens considerably. Walking becomes the second best alternative on such short distances. Moreover, multi-modal trips can be taken into account, by combining the score of the public transport systems with bicycle and walking for transport going to and from public transport stations. This also only has effect on short distances. On short distances considerable worsening of the public transport modes can be observed. On longer distances, such multi-modal trips show sssv comparable to that of single mode public transport trips.

Dynamic outcomes

With the aid of scenarios, also future sssv of transport modes can be calculated. No major changes in the ranking order of transport systems can be expected. New fuel-efficient technologies only slightly improve the score of the passenger car. Only with an important decrease of the service level of the public transport systems, the sssv of these systems worsens to such an extent, that these become comparable on long distances with the score of passenger cars.

Further considerations

The TCC also enables to calculate characteristics of transport modes by urban setting. Differences in mobility patterns among inhabitants of various urban settings hardly influence the sssv of transport modes. Due to a lack of data on variations in the speed distribution of roads in the various urban settings, and on variations in the use of road types for various trips among various urban settings, the differentiation to urban setting is not a valuable addition to the model. In general, it can be stated that the level of mobility demand hardly influences the sssv of various transport modes. Apparently, characteristics are rather insensitive to the mobility demand. Congestion hardly influences outcomes either, as this has a negligible effect on overall average travel times.

The conclusion that the bicycle and the train (or a combination of these modes) form the best transport systems is rather independent of further specification of the result by trip length, multi-modal trips or by possible future changes of transport systems. A more important consideration in determining the outcomes is the choice of the characteristics. The choice to include two societal characteristics (space use and energy use) and two individual characteristics (costs and travel time) is important in the determination of the overall ranking order of the transport modes. Omitting one of these variables, or including another variable in the analysis influences the ranking order. A large variety of other variables could be included in the analysis, such as emissions, reliability, safety, comfort, etc. In general, the addition of extra variables improves the score of soft modes.

In practice, not all transport modes can be used on all trips. When taking specific trips into account, the train is not a valid option for the shortest distances. Soft modes are generally no realistic option at longer distances. When using routes of specific trips, the bicycle is clearly the only best mode over its full user range. On longer trips, a combination of public transport modes and soft modes when necessary, provide the best option in all trips considered.

The calculated characteristics of transport modes cannot be used to explain individual modal split choices, even when taking only individual characteristics into account. Calculated characteristics are always based on real average values, which does not equal perceived values by individuals. It is known that waiting time is valued differently than in-vehicle travel time and fixed costs are generally valued differently than variable costs. Although these characteristics are used as indicators of individual preferences, they do not represent the values used for choosing transport modes.

Altogether, the conclusion that the train, the bicycle or a combination of these modes are the most favourable transport systems in the Netherlands, remains valid in all further specifications.