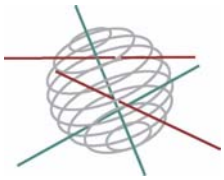
SCIENTIFIC SUPPORT PLAN FOR A SUSTAINABLE DEVELOPMENT POLICY
(SPSD II)



Part 1:
Sustainable production- and consumption patterns

SUMMARY

Determinants of choice of mode in trips and trip chains

CP/B8/421

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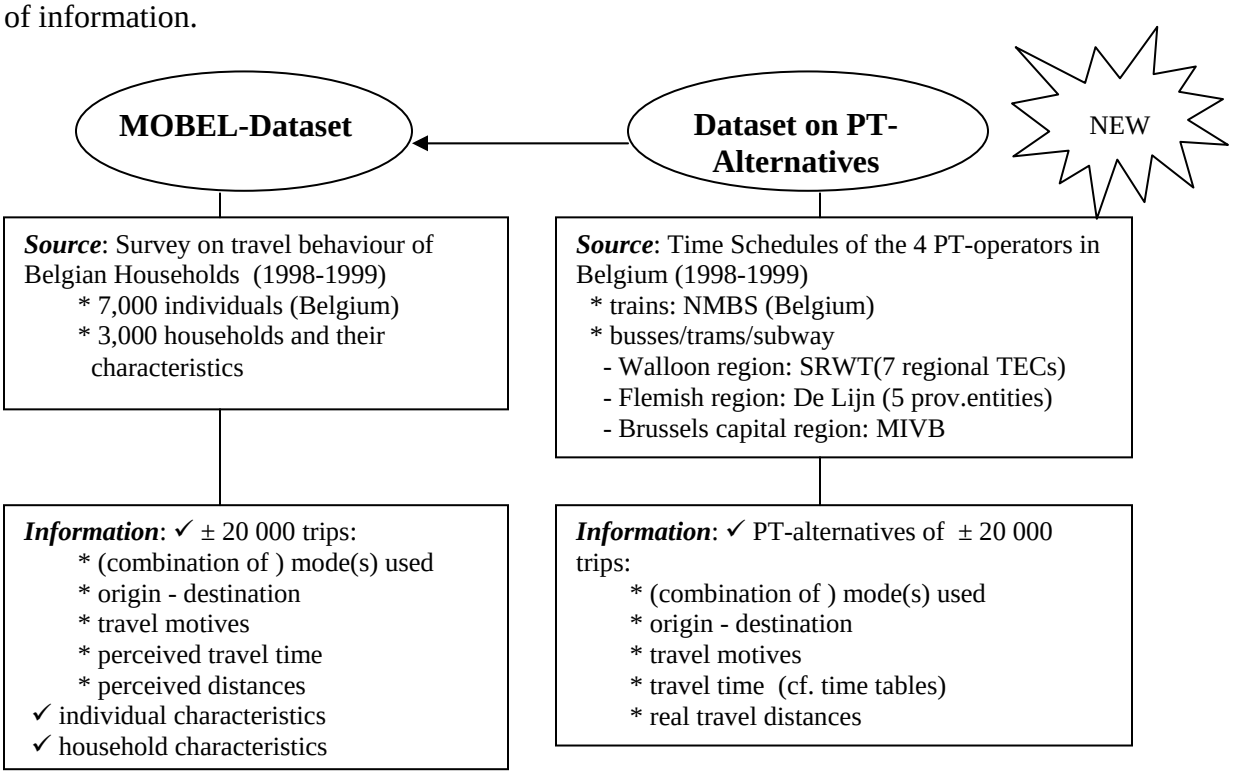
1. The research

1.1 Aims and methodology

The aim of this study was to gain insight into the determinants of mode choice in trip chains. This information is of value to policy makers and public transport (PT) providers as it provides the knowledge on the potential PT-customers and offers input on how to improve the public transport supply. Within this research project, a literature study is combined with statistical analyses on an existing cross sectional database (MOBEL-dataset) and with statistical analyses executed on a new subset of this database (Dataset on PT-alternatives).

The literature review aimed at giving an overview of the knowledge on all factors determining the choice of mode in trips and trip chains. In recent international literature, a lot of information can be found on trips. However, far less is publicised on the factors determining mode choice in trip chains. Therefore, the task was first to operationalize the concept of trip chains and then to investigate this topic through statistical analyses. Within this statistical research part, two datasets were used: the MOBEL dataset (1998-1999, constructed under the SPSD I-programme) and a new dataset with PT-alternatives. The following scheme describes the two datasets with their respective resources and type of information.



In the new dataset on PT-alternatives, the information of MOBEL is completed with information on the available public transport supply at the time of the survey (1998-1999). More concretely, for every trip made (irrespective of the mode used), a PT-alternative is explored. This information is taken from the timetables of NMBS, De Lijn, TEC and MIVB at that time. In this way, an idea of the percentage of the current private car users that ideally also could have chosen the public transport for a specific trip is attained. For the trips actually made by public transport, we get information on the "perceived" travel time and distance (info from the survey) versus the "objective" time and distance (information from the PT-time tables).

1.2 Terminology used

The MOBEL-dataset defines a *trip chain* (chaîne de deplacement) as a loop (boucle) between origin and destination "home" and all trips with diverse destinations that take place in between. All loops with "working place" as origin and as destination are also considered as trip chains (e.g. shopping during lunch time; work-shopping-work).
A trips chain is composed of different individual *trips* that differ from one another by destination or trip motif.

All individual trips can be done in a unimodal or in a multimodal way. The use of each mode separately within one trip is called a *subtrip*.

This research covers determinants of mode choice in individual trips (A-B, B-A, B-C) and of mode choice in trip chains (A-B-C-D-A, D-E-D).

1.3 Position of Research and Literature Study

A lot of research has been done about demand- and supply related factors determining mode choice. These studies are often based on single trips and do not take into account the fact that nowadays combined trips are more and more taking place. In order to make these trip chains sustainable, better insight is needed in the factors that determine mode choice in trip chains.

At the *demand* side, first of all the spatial structures determine the existence of trip chains; more concretely the relation between distances with different modes, location patterns (the geographical location and the urban character) of destinations and living environments are important determining factors.
Also personal characteristics (working versus non working, age, children, etc.) determine the travel demand.
Analyses of mode choices without making distinction between single trips and trip chains do no longer make sense. In many cases, trips are just one part of a certain type of trip chain. By making trip chains, people can save up to 15 – 20% of their travel time. Looking at single trips therefore is no longer correct. This hypothesis is being tested within this study. The decision process that people make about their travel mode is depending on a complete range of activities generating different trips. Complex interactions between activities (travel motives) and mobility must be taken into account.

At *supply side*, travel time seems to be the ultimate decision criterion for the mobility behaviour of the consumer. Although the home - work distance has increased on average during the past 25 years, the mean travel time of a trip hardly changed. The mean trip speed has thus increased and this has caused a modal shift towards the fastest alternatives. One assumes that the traveller likes the shortest travel time and has chosen the best travel mode within this respect.

- Different time components have to be looked upon, such as preparation time, waiting time, effective travel time, transfer time and the time needed to reach the travel mode or stop. These components are important as travellers appreciate these components in a different way. Waiting times and transfer times are rated negatively.
- Public transport appears to the « choice »traveller as an alternative when the travel time factor does not exceed 1.5 (the travel time factor is the ratio between the travel time with PT and the travel time by car).
- Also the reliability of the travel time is important. PT-travellers prefer a longer (in time) trip above a shorter but unreliable.

A second supply related factor is the comfort in all its aspects, the comfort of the vehicle as well as the driving comfort, but also information and social security for the travellers appears to be important.
A third factor is the ease of use. In public transport, this ease is reflected within the network structure and the concepts of functioning of transport nodes (transfer points and important PT-stops).

1.4 Interpretation of the differences in between the two datasets

The statistical analyses on both datasets have been focused on the following issues related to trips and trip chains:

- relation between household characteristics and mode choice;
- relation between the spatial structure and mode choice;
- relation between the characteristics of the public transport supply and the travel mode choice.

Analyses are conducted to know the reasons why sometimes a PT alternative is not available. Structural differences between the reported (perceived) PT-route in the survey and the same route according to the PT-time tables of the PT-operators are investigated. The decision criteria underlying the travel information systems of the public transport operators are being assessed.
The comparison between the two datasets revealed significant differences between perceived and measured PT-trips. It shows that the searching robots and shortest distance methods do not take sufficiently into account the preferences of the traveller regarding the travel modes and the number of transfers. As for the travel time, the differences are smaller and differ in between the three regions.
The observed differences can be explained fairly easy from the fact that the PT-travellers and PT-operators both use a different logic. Sometimes the traveller takes a slower PT-connection to avoid an extra transfer or a delay. Sometimes he prefers the subway above a faster alternative because he expects a larger regularity. Sometimes he prefers to use the

bike or the car as pre-or post transport means. Searching robots however don't take these options into account.
Another explanation for the observed differences is that each PT-operator adopts his own coefficients and weights within their searching robots that best suit their working field. Metropolitan customers are used to high frequencies and have other preferences than customers from rural areas or long distance travellers that have a smaller range of PT-services on offer.

1.5 The impact of household and personal characteristics

It has been investigated which combination of household and personal characteristics play an important role in the mode choice of a household and its members. The use of different available transport modes and the partition of these modes between the household members according to the needs have been looked upon in depth. It has been investigated whether a relation exists between the family structure (couple, single parent household, the presence of children, etc.) and the mode choice. Do collective trips (different household members sharing the same transport mode) influence the mode choice? Also a profile is made of persons and households for whom a public transport alternative has been found.

It appears that the differences between household profiles of car users versus PT-users are dominant. Car users retain the profile of a car user irrespective of the fact whether they have a high quality PT-alternative available or not. However there are household characteristics that explain why there is no - or only a moderate to bad - PT-alternative to be found and why the car is being used. One of them is the distance between the house and the closest PT-stop. And in case of a significantly bad PT-service at the working environment there are most of the times good car parking opportunities or at least car parking is no problem.
Of course the availability of the car plays a crucial role in the choice of the mode of all individual household members both as driver or as passenger. The availability of a car is also related to other household characteristics such as income, the place of residence, the size and structure of the household (number of active members, generation, children, etc.) In households with more drivers than cars available, there often is one 'main driver'. Often this person uses the car during the whole day. And this could point at a limited modal flexibility at the household level.
Finally, the large number of persons travelling by car (even within households where no car is available) reveals that the car is a very attracting travel mode.

1.6 The Impact of Time and Space

The impact of time and space on PT-use is traditionally being quantified is terms of elasticities. The estimates of travel time elasticities distinguishes the various travel time components such as effective travel time, waiting time and walking time.
The link between the travel time ratio and the travel distance is looked upon for different travel modes. More over, the critical travel time ratios are being measured.

A comparison of the travel times by car and by PT allows for more detailed analyses of the impact of travel time and distance on mode choice. Some elasticities do not reveal more than evidences because some types of modes are only of value within certain time-distance framework. The relation between the total travel time by PT and the effective PT-use is rather weak and could better be described by means of the travel time ratio. Walking times up to 10 minutes have only little impact on the PT-use. With higher walking times, the share of PT-use declines drastically. Note that the decline only starts at the moment that the share of walking time within the total travel time is 30 to 40 percent. A relatively high share of walking time thus is considered acceptable. W.r.t. waiting times, the conclusions run parallel, however the elasticities are higher (in absolute terms) than for walking times. For waiting times, the maximum acceptable share within the total travel time is 20 percent.
A significant relation is found between the travel time ratio and the PT-use with elasticity estimates in between –1 and –1.2. The course is characterized by a fast decline until a travel time ratio of 1.5 to 1.6 followed by a much smaller decline. These figures are in line with the maximum travel time ratio that "choice" travellers have considered as acceptable.
The travel time ratio is the variable regarding travel time that explains best the mode choice. Distinction between "choice" travellers and "restrained" travellers reveals that higher elasticities are obtained for the first group of travellers. The use of the concept of generalized travel time - taking into account differences in perception between the travel time components – provides a partial explanation for the variance in PT-use. Estimates with one minute of waiting and walking time weighted as respective 1.5 and 1.9 times a minute of effective travel time and one transfer as 10 minutes of extra effective travel time give the best estimates for the perceived travel time. Elasticities show that the gain in walking time and especially the gain in waiting time better explain the mode choice than does the gain in effective travel time.

1.7 The Impact of Trip Chains

The relation between trip chains, trip distance, personal and household characteristics and mode choice has been looked upon in depth. Three types of chains have been investigated: trip chains with "missing links" (these are chains where one or only a few (sub)trips were not possible with PT), chains that are completely possible with PT and chains that are completely not possible with PT.
Which trip chain characteristics have an impact on the mode choice and which trips are considered the weakest link in the chain?

10.1% of the trip chains are by no means replaceable by a PT-alternative. 32.2% can be completely replaced by a PT-alternative. The length of the chain (number of (sub)trips in the chain) has got no univocal impact; in rather simple chains a larger PT-replaceability exists; this declines until five trips and from then on remains fairly constant. In the Flemish region, this replaceability starts to incline again. This can be explained by the relatively large share of short distance trips in longer trip chains - especially in cities - for which "walking" is a feasible alternative.

1.8 Analysis of "Missing Link" Trips

"Missing links" are one of two trips within the trip chain that are responsible for the fact no complete PT-alternative could be found for the whole chain.
Chains of more than 10 trips with missing links are situated almost exclusively in big cities.

It appears that the missing links occur more often as the last trip in the trip chain. Also the first position within the chain is slightly overrepresented. People usually have more alternatives at their disposal for home based trips. For this type of trips people dispose of extra transport possibilities such as the bike or the car (taxi, P&R) that are not available for other trips in the chain. The missing links are most of the time made by car and not by bike. Only in Flanders, the bike takes up a relevant share. A substantial part of the trips is made on foot.
The percentage of trips without a PT-alternative is relatively low for some travel motives, such as for home-school travel and shopping. These destinations are usually centrally located. For other motives, this is clearly not the case, such as for family visits. Missing links take - not completely unexpected - relatively more place in the evening and at night.

1.9 Analysis of the Factor Time in Trip Chains

A first conclusion here is that the travel time ratio is lower in trip chains in which a PT-mode is used. This is in line with the conclusions at the trip level (see § 1.6) and confirms the significant relation between the travel time ratio and the PT-use as said earlier. Secondly, it appears that the difference grows as the length of the chain grows. This is probably due to the fact that for PT in large chains, the requirements towards travel times become more stringent.

Next to the travel time ratio, also waiting time, walking time and the number of transfers are important time variables. The analysis shows that at trip chain level, these variables explain better the mode choice than at trip level. Moreover the global waiting time within the chain has – similar to the trip level – a bigger impact than the global walking time. Especially the travel time ratios of the trip to the *main activity* and of the trip with the worst PT-alternative are of importance at the trip chain level. These figures have a higher impact than the travel time ratio of the trip.

1.10 "Main Activity" in Trip Chains

The hypothesis was that people decide their mode choice on their trip to the main activity. All other trips in the chain would be subordinate to this choice. Within the study it has been investigated whether the availability and the quality of the PT-alternative to the place of main activity has an impact on the mode choice in the trip chain. The estimated value of the travel time ratio of the trip to the main activity turned out to be significant.

The range of travel time ratios within the trip chain and the travel time ratio of the trip to the place of the main activity turned out to be better explaining factors than the travel

time ratio of the individual trips. This confirms the statement that the mode choice not only depends on the quality of the PT-alternative of each single trip separately but on the quality of the PT-alternative for the whole trip chain and on the trip one makes to the main activity. In most of the cases this main activity is "school" or "work".

1.11 Intermodal Trip Chains

For chains with PT and car as main mode, walking is the most frequent *additional* mode. Public transport and the bike are only sporadically used as an additional mode in trip chains except for PT as additional mode to 'walking'. Both modes are rarely used in trip chains except when they take up the role of main transport mode.

1.12 Potential Public Transport chains and Car Chains

A significant difference exists between PT-chains and car chains regarding the mean length of the chain and regarding the mean travel time. Chains that are completely replaceable by PT are on average longer than chains that are not replaceable by PT. The mean travel time for chains that are completely replaceable by a PT-alternative is on average much shorter than for chains that are completely irreplaceable by PT. There is no difference in duration of the activities within the chain.
The trips in the chains that are not replaceable by PT are usually made by car (86.3%) and to a lesser extend by walking (4.8%) or by bike (3.2%).

2. Policy recommendations

2.1 In General

A large market of trip chains has been formed due to growing mobility needs, spatial changes in the urban development and due to different sociological changes in the area of working, the composition of households and task division in the households, changing recreational patterns, consuming patterns and life style.
The dataset MOBEL from the SPSD I-programme, has made it possible to analyse in depth these trip chains and the factors influencing the mode choice.

The role of PT in this chain mobility is somehow difficult to estimate because of the occurrence of missing links in the PT-services. As a result even a larger car dependence is likely to develop. Moreover, using PT in all links of a long chains requires from the customer a very good insight into the PT-network and its services – especially for non habitual trips. And this is not obvious at all.

On different policy levels, themes such as chain mobility and related issues are put on the agenda and taken op in mobility plans, policy notes and management contracts of PT-operators. In the years to come, one might expect a further realizing of this policy theme in the field. The chain approach of trips will be an important starting point in this.

Within this framework, a list of policy recommendations is formulated below.

2.2 With Respect to Data Availability

The first proposition is to set up a central database in mutual consultation between the federal and regional administrative levels. This database should contain all timetables, routes, stops and tariff information of all PT-operators that are operating in Belgium. The obligation to deliver this information should be established through the respective management contracts of the PT-providers with their government. For research purposes (dating, time series, etc.) the basic databases of this information should be remained accessible during at least a number of years (e.g. 25y) back in time.

Moreover, also at the EU-level a need exists for cross border links of PT-data and for standardisation of different front office media aiming at improving PT-travel information for cross border PT-related door-to-door trips. The federal and regional governments should sustain these evolutions.

2.3 With respect to Planning and Implementation

Regarding spatial planning, this study demonstrates the possibility of creating favourable conditions for PT even outside urban areas. For this purpose, more attention is requested for a highly qualitative accessibility of condensed corridors by PT.
Within these corridors new PT-services can be built around high standard trunk lines, (lines with high frequencies and fairly no interruptions). This asks for a well developed

net management based on a hierarchical network. In such a network, more transfers should be made possible. This is also the image one gets from sociological changes nowadays: the largest growth in mobility takes place in more spread locations tangents to the city centre. For these trips, most often the car is used; For if people want to use PT, they need to make one or more transfers in between different modes.
The study reveals that transfers are being sanctioned but at the same time it becomes clear that the most important reason for this is the unreliability of the PT-service offered. Other elements are the untransparant structure of the net and of the tariff system and the difficulty to obtain PT-information.
This last aspect has got different faces: the regular information is not always available in a sufficiently integrated way: a barrier remains in areas in which one is no habitual PT-user. The service irregularity can make the provided information unusable, including the information from route planners. For this reason, real time information and incident management are important.
The government should provide integrated PT-information. In other countries, market developments have in certain cases lead to desintegration and to a rise in the costs of information provision.

Trip chains around cities with two or more PT-operators require further integration of the services, information and tariffs following the example of the German Verkehrverbunde and the STP in Paris (FR).

The problem of PT-service irregularity is commonly accepted as one of the most important barriers in modal choice towards PT. However on the quantitative level, little study work has been done in Belgium. In the current multimodal models, PT-regularity is treated as an exogenous variable not as an endogenous. An important effort should be made to introduce within these models a reliable quantification of (ir)regularity of PT-services and its impact.

Our cities are becoming real network cities. Trips in peripheral areas in between 10 to 30 kilometres are most of the time made by car. An important share of the trip chains originates in these peripheral areas and the market share of PT here is traditionally small. The government should provide incentives for the development of pre-urban light rail systems with the high quality standards of the train but with much more attractive routes, infrastructure, type of services, etc. For this purpose, the technical and administrative conditions should be installed where needed. NMBS and the regional PT-operators should in mutual consultation together operate railway tracks or delegate it to the operator who is best placed to run these new systems.

Regarding further research, initiatives should be taken regarding quality aspects of the PT (accommodation, quality of transfer points, etc.), the integration of the regularity as an important factor in multimodal models, and the take up in surveys on travel behaviour of questions relating to trip chains and intermodality.