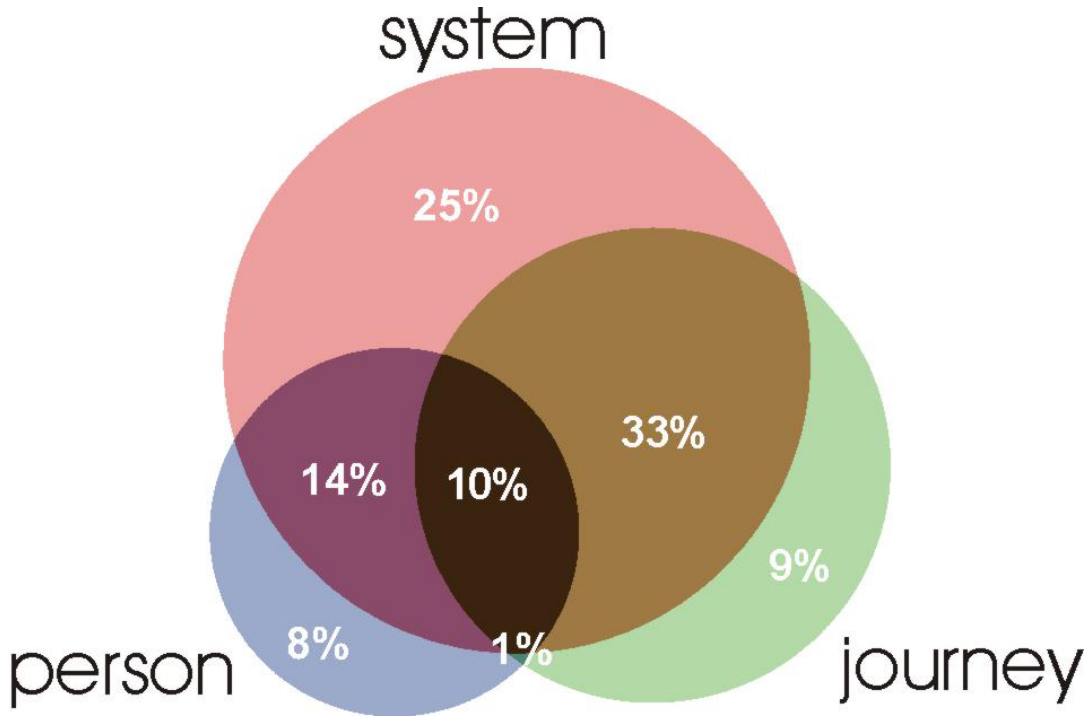

Unselected mode alternatives: What drives modal choice in long-distance passenger transport?

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Unselected mode alternatives: What drives modal choice in long-distance passenger transport?

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Abstract

Understanding the process of modal choice behaviour in long-distance travel is one of the main objectives of the INVERMO project. Based on the extensive survey data collected in the ongoing project we present a collection of initial results.

Referring to respondents' answers about mode alternatives in long-distance journeys that were finally not chosen, we found that significant shares of decision makers seems to do no choice at all. Due to this finding we analysed the recorded survey data with respect to possible determinants explaining this effect. When alternative modes were considered the surveys records reasons for finally excluding these modes. The given answers allow a broader view on the choice determinants.

Based on this we suggest a three-level system to differentiate the determinants of choice making in a travel context. Besides system-related issues we recommend that mode choice models shall explicitly consider the traveller's personal situation as well as the individual journey's context. A suggestion is made how restricted choices can be considered in a simulation model.

Keywords

Mode choice, long-distance travel, choice determinants, journey context, personal characteristics, intermodal, International Conference on Travel Behaviour Research, IATBR

Preferred citation

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1. Introduction

Modal choice can be seen as one of the most challenging topics in travel behaviour research. Although decades have been spent in studying the determining factors only partial progress has been made since. Beside the interdependency of modelling ideas and the techniques, a lack of sound and sufficient theory on human decision making as well as the limited availability of appropriate data hinders larger steps towards understanding choice behaviour and suitable modelling. This applies to everyday transport as well as to long distance travel in particular.

Integrated transport supply, also often named intermodality, raises new questions that can not be answered in a standard way. The use of two or more modes during a single journey[1] is not new at all. Travellers used e.g. public transport on their ways to and from airports since decades. We are used to consider single modes but the necessary focus must changes when explicitly taking transfer points into consideration. As travellers do not only evaluate the main mode of a journey, the decisions concerning used modes, routes or starting times can not be described with classical modal models. The significant increase in complexity that has to be handled when coping with integrated transport systems is a challenge that transport analysts, scientists, statisticians and also modellers have to face[2].

Since Spring 2001 Lufthansa German Airlines and German Railways (Deutsche Bahn) offered a joint product named AIRail between Stuttgart and Frankfurt/Main. This transport service allows Lufthansa customers to check in (also with baggage) at Stuttgart Central Station and take the high-speed ICE train to Frankfurt/Main Airport by using a flight coupon for this trip stage. In Frankfurt the traveller has usually a minimum connecting time of 45 minutes to transfer to any Lufthansa flight worldwide. On return flights customers can pick up their baggage and pass customs in the Stuttgart railway station.

[1] The European Commission defines intermodality as the use of two or more modes in an integrated manner in a door-to-door transport chain. (Source: European Commission (1997): "Intermodality and Intermodal Freight Transport in the European Union")

[2] In 2002 the Deutsche Verkehrsforum recommended that we have to get away from an intermodality, that still treats modes separately, but we should turn towards a transmodality with seamless transfers that customers do not notice.

AIRail's seat load factors were only as low as 30-40 percent for the time being. Hence the question was raised why the majority of customers still use the parallel flights between Stuttgart and Frankfurt although e.g. AIRail users, marketing experts as well as travel agents emphasized the comfort and high quality of this new service. Lufthansa's interest in shifting flight passengers to the rail aimed at getting rid of non-profitable ultra-short-haul flights and freeing slots at airports working to capacity like Frankfurt/Main.

In parallel Lufthansa and German Rail joined the public co-financed project INVERMO on intermodal linking in passenger long-distance transport considering especially user needs. One major objective of this project is the identification of barriers to intermodal travel behaviour as well as recommendations how to overcome them. The Institute for Transport Studies (IfV), Universität Karlsruhe is in charge of scientific leadership in this project.

The IfV runs also other surveys on everyday transport regularly and is therefore experienced in intra-personal analyses and micro-simulations in travel context. Although extensive data on travel behaviour is at hand at the IfV, e.g. only 1.3 % of all trips recorded in a German everyday travel panel are long-distance. Thus, the project's objectives comprise also the development of a suitable data source for journeys with a minimum one-way distance of 100 kilometres .

2. The INVERMO data

A basic idea of INVERMO was that a better understanding of intra-personal travel behaviour will lead us to the aspects of interests, i.e. whether a certain type of traveller will be or will not be a potential user of integrated services. Due to the lack of data INVERMO implemented a long-distance travel survey that started in the year 2000. The still ongoing survey combines cross-sectional and longitudinal surveys elements. Cross-sectional data supplies a representative picture of travel behaviour at a certain moment in time. The longitudinal components of INVERMO additionally allows insight in intra-personal decision making. As long-distance journeys are rare events compared to everyday mobility, the survey focuses on individuals with an above-average long-distance mobility.

The survey design consists of three stages: first stage is a screening survey that comprises 17,000 representative phone interviews on long-distance travelling. In this survey the interviewees reported the number of long-distance journeys per year, their last three journeys and some socio-demographic aspects. The socio-demographic data allows for the use of this survey as a weighting frame for the other parts of the INVERMO survey.

The second stage, the main survey, is a panel-like postal survey of respondents of the screening survey. As the share of persons with above-average mobility is small and the proportion of the population with (nearly) no long distance mobility is substantial, highly mobile persons are over-sampled in this second stage in order to economize the survey. These individuals joined three eight-week survey intervals in which they reported up to five long-distance journeys in detail. The questionnaires cover pre-trip planning and mode choice, on-trip details by each trip leg (e.g. origin, starting date and time, vehicles used, routing, destination, arriving date and time, trip purpose, intermediate trips at the destination). The first three waves of the enquiry comprise 2,062 individuals reporting 6,248 journeys. The fourth wave is currently underway and will cover approximately another 600 journeys.

In the third and fourth wave additional items were added to the household questionnaire in order to obtain more knowledge on the individuals' background. One element aims at details about general modal preferences while another tries to assess the individuals' propensity for innovations. Experts' interviews with psychologists and sociologists result in the idea that these aspects could be dominant in mode choice especially with respect to integrated services.

In the last survey stage 300 phone interviews will survey stated preferences on so-called intermodal services. Interviewees are recruited out of the second stage participants. This incremental design ensures that also details from previous stages can be considered in analyses.

First INVERMO based mobility key figures are widely comparable with other existing German data sources. Cross-sectional surveys like the 'Mobilität in Deutschland (MID)' or the 'Mobility 2001' generate similar measures for individual travelling[3]. Further on the weighting scheme applied for INVERMO data shows only correcting factors close to one. These aspects makes us confident that the information collected in INVERMO is representative for long distance travel behaviour in Germany. Furthermore we presume that the dataset or the conclusions drawn from it can also be applied generally for analysis on a Western European level.

In the following section we will present some first results[4] from INVERMO with focus on the respondents' answers concerning transport modes considered in pre-trip planning.

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[3] Also the longitudinal German Mobility Panel (MOP) 2002 that captures everyday travel results in figures that meets the key figures of INVERMO.

[4] A more general overview is published in Last, Manz and Zumkeller (2003): Heterogenität im Fernverkehr – Wie wenige reisen wie viel? (Heterogeneity in long-distance passenger transport – how few travel how much?), in: Internationales Verkehrswesen, 6/2003

3. Initial findings

In the second stage of the INVERMO survey the respondents were asked whether they had seriously considered alternative modes while planning a specific journey. Given that for 15 percent of all long-distance journeys travellers have no influence on the mode of transport[5] or only one mode is available, for the remaining 85 percent alternative modes could be taken into account by the travellers. Keeping in mind that people are less habituated to long-distance journeys due to their exceptional character, we expected that for a major share of this latter journeys people's choice sets consist of two or more modes.

A first analysis of the data showed that real choice, i.e. journeys with potential alternative mode, can be found only in every seventh reported journey. Thus, only for 13 percent of all potential journeys the respondents stated that they considered an alternative mode during their pre-trip planning seriously. This finding was contrary to our expectations and caused our interest in further details. We were very much interested in the reasons why choice sets with two or more modes are not the standard.

Having a look at trip purposes we found that considering alternative modes is much more common when planning business (18 %) than holiday journeys (11 %). Visiting friends and relatives is on the average level (13 %) and other private trips a little above (14 %). For trips abroad 11 percent of all people consider more than one mode while for domestic trips 14 percent do so. Only 11 percent of the respondents stated that they consider alternative modes when planning a one-day trip but 15 percent for a weekend and 17 percent for an absence from home that lasts four to seven days.

Although there is a variation between different subsets of travellers the share of real choices is quite limited in all cases. Comparing journeys with and without choice might give some indication for possible motives: "No choice"-journeys are dominated by car while "choice"-journeys showed higher rail shares. Further on more business and less private one-day trips can be found in "choice"-journeys.

If we refer to the individual trip situation we find that for slightly more journeys (15 %) people think about other modes when they don't have to carry bulky luggage. If trips are planned

[5] Journeys for which alternative modes are irrelevant are e.g. intercontinental trips where only flying is appropriate in most cases or when booking a package holiday where the package include a certain transport mode in almost all cases.

very shortly (starting date, 10 %) or very long before (more than one month, 11 %) the figures are below average but if plans were made the week before the share of "choice"-journeys raise to 16 %.

An explanation for reduced choice making can be a form of habitualness in using certain modes. Such effects are well-known in everyday transport but are not observed in long-distance transport as far as we know. Keeping in mind that the distinction between local, regional and long-distance travel is artificial, habitualness could also be of relevance for the long-distance journeys surveyed in INVERMO. Selectivity might be another source of biases from our point of view.

Another relevant source of bias could be the question statement: "Did you seriously take an alternative means of transport for this journey into consideration and if so, which one?"[6] The respondent's interpretation of the adverb 'seriously' can be somewhat vague. Unfortunately we are not able to derive more details on the understanding and the respondents awareness of their decision making. Further studies have to undertake more in-depth analyses of the processes underlying the choice making.

A possible third reason is that decision makers are captive to certain modes. This means that we have to switch from the journey to the individual level to analyse this appropriately. Unfortunately the whole picture above is only drawn from cross-sectional information and does not allow to dig into the data with a focus on intra-personal relationships. We will return to this issue later in the paper.

We can summarize that for the majority of long-distance journeys a rational decision making considering a set of modes does not take place. Therefore, the assumptions underlying numerous models are not realistic. Thus, a new generation of models has to capture additional determinants of individual choice. In the following section we will therefore going to develop an suitable scheme of choice determinants.

4. Determinants of modal choice

When asking researchers of different scientific background about the factors that drive modal choice, one would get answers that do not coincide necessarily. E.g. transport engineers might

[6] Translation of the German question statement: "Haben Sie ein alternatives Hauptverkehrsmittel für diese Reise ernsthaft in Erwägung gezogen und wenn ja, welches?"

state that travel time, costs and transfers will be the most dominant aspects. Psychologists will refer to e.g. attitudes and behavioural patterns. Economists will point out the relevance of advertising, service levels and utility. An interesting question is: What would be the ranking of relevant aspects if all these scientists had to work together in an interdisciplinary project? We can't answer this really but we will try to categorize the determining factors of mode choice on a meta-level.

We identified the following three major fields:

- system
- situation
- person

The 'system' field comprises the available set of alternatives and all their characteristics. This means e.g. network densities, accessibilities, frequencies, prices and levels of service. 'System' summarizes all supply related aspects that do not change between individuals and trip motives.

The 'situation' context includes all aspects that refer to the single journey. Trip purpose, distance to travel, type of destination, group size or baggage are examples of characteristics of journeys that may have an influence on the decision making.

The item 'person' stands for the individual traveller and his characteristics. It captures e.g. abilities, habits, knowledge, experiences and modal captivities. All these aspects are more or less subjective and therefore not easy to measure. Nevertheless we expect that their impact on decision making is possibly strong and can not be neglected a priori.

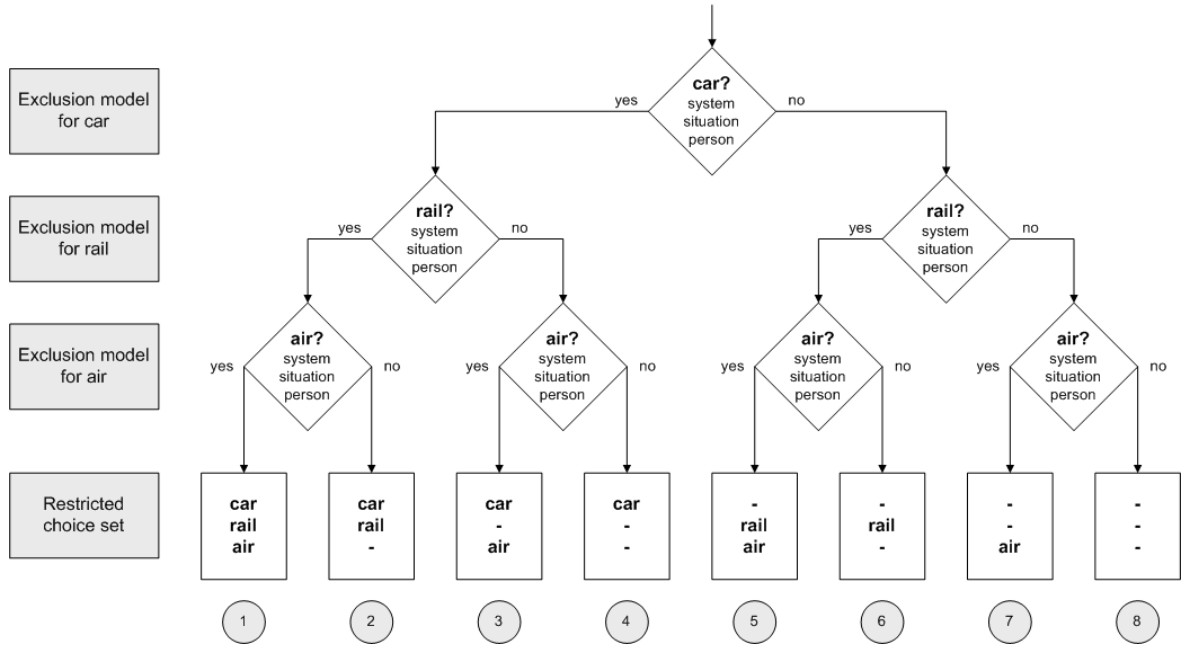
We are sure that the consideration of the situation and the person is essential in decision making e.g. due to the fact that single aspects of them could lead to an exclusion of alternatives from a choice set. Fear of flying will probably lead to not considering the aircraft equal to other alternative modes. In such case flying is excluded from the choice set right from the beginning and the choice is only between the remaining modes. This is a constraint on the 'person' level.

Another constraint on this level could be the inability to use e.g. public transport. If somebody never travelled by train before he may not possess the 'modal competence' to use the railway, i.e. he does not know where to buy a ticket, how to read a time table, where to change trains on a transfer connection, etc. Although these matters can be learned easily when the decision

to use the train is made, the lack of modal competence and its awareness can be a severe barrier to including a certain mode into the choice set.

Considering the 'situation' level one could imagine that a traveller has to carry bulky and heavy baggage. Referring to public transport it could be assumed that he can check-in his baggage at the airport and the flight might be quite comfortable even when he has to transfer. In a railway system[7] he has to take care for the baggage himself and have to handle it all the way – also during transfers. Although he might be a aficionado of rail transport he might discard the rail alternative from his choice set due to the given situation.

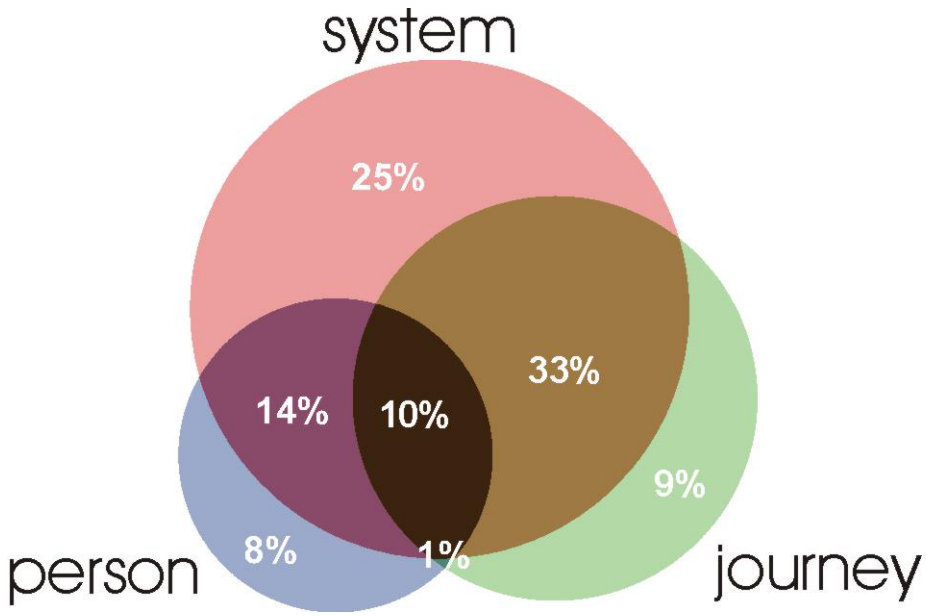
Figure 1 Stages of choice making: personal, situational and systemic level



It is not the intention to imply that all journeys will be affected by such personal or situational limitations but we think that it is useful to consider these choice determining aspects to a larger extent in future surveying and modelling contexts. Knowing that person-related aspects of mode choice raises the complexity in model development and model usage significantly, we are also sure that such more complex models will capture the decision making process much better and therefore produce more appropriate results. The on-going diversification and individualisation of services and products also in the transport sector needs precise answers to very detailed questions.

[7] The German Railways e.g. abolished the possibility to check-in baggage and to transport it parallel to the traveller some years ago.

Figure 2 Sets of reasons for rejecting alternative modes



We therefore propose a combination of models that serves the idea described above. By combining classical models with preceding exclusion steps the choice sets will be restricted to those alternatives that are truly considered by a traveller. If we implement one exclusion stage for each mode allowing to decide whether this mode has to be excluded from the choice set or not, then a decision tree[8] exists as depicted in Figure 1. Each modal decision comprises criteria from the personal, situational and the system level. The leaves of the tree represent the possible choice sets. Our findings indicate that the majority of choice sets are those of type 4, 6 or 7 (see circled numbers in Figure 1). Classical models suppose that almost all choice sets are of type 1. More in-depth analyses are required to decide which one is closer to the truth.

The answers to another question in the main survey underline the latent relevance of determinants apart from the classical ones: time, costs and comfort. We asked for reasons that caused the decision against the alternative mode.[9] While 17 % stated only classical reasons, a share of

[8] For simplification we avoid to depict the single decision level in which certain modes are excluded or not. We assume that a single model for a specific mode that comprises effects from all three levels could be a good substitute for three (level) times three (mode) individual models. Thus, three models are combine to a single mode-related one .

[9] Selectable reasons (multiple choices possible) were: too slow, too expensive, too uncomfortable, baggage transport too uncomfortable, too laborious or nerve-wracking, preparations too expensive, less reliable/ congestions expected, too elaborate with children, too elaborate with pets, destination is not or only difficult to

67 % named classical and other reasons together. This means that for one third of all journeys reasons are decisive that are only non-classical. In every second journey situational aspects influence the choice making, in 36 % of all journeys transport system-related reasons additional to the classical ones are relevant and in 32 % personal factors played a role respectively.

In the next section we are therefore going to focus more on these non-classical decision determinants.

5. Choices are more complex

In the last section we showed that not just the transport system itself determines the decision making when travelling. Although the journey's situational context is of relatively great importance we will concentrate on the personal context in the following. Habits, experiences, knowledge and preferences can influence choice behaviour significantly and should not be ignored when analysing and modelling travelling.

INVERMO tries to capture these aspects to a certain extent when designing the survey components. As always, time and budget constraints limited various interesting ideas to be considered in the enquiries but the information gathered is quite promising. Due to its panel concept the data allows to derive a bunch of details about the individuals "behind" the journeys made. We are confident that an enhanced consideration of personal aspects will foster the understanding of behaviour and decision making, and will also be an impetus to new modelling concepts for long-distance travel.[10]

Tests on socio-demographic and economic characteristics of travellers that generally had the opportunity to choose an alternative mode[11] against those that never stated alternative modes in pre-trip planning showed that classical model variables like gender, car ownership or in-

accessible with this mode, private car needed at the destination, private car nor available for this journey, weather conditions, other.

[10] In everyday mobility comparable steps were made when focussing e.g. on activity-based approaches. The idea is that individuals and their specific situation could be much more a limitational factor than every characteristic of the transport system could ever be.

[11] A person receives a mark "no alternative" if it stated for none of its journeys that an alternative was seriously considered, otherwise (if at least for one reported journey an alternative was named) we set a mark "alternative".

come have no significance. Nevertheless other surveyed characteristics seems to have explanatory power. It is obvious that the possession of frequent traveller cards (for railways and/or airlines) correlates with choosing between alternatives because it lower the threshold for using public transport. Nevertheless the question remains whether card ownership supports higher mobility or is an outcome of it. Thus, frequent traveller card ownership can be linked transitively to other determinants of higher mobility.

We classified the surveyed travellers into three distinct groups: persons reporting low (less than 6 journeys per year), medium (6 to 35 journeys per year) and high mobility (more than 35 journeys per year). While an average share of low and medium mobile people (approx. 13 %) stated that they consider alternatives when planning a trip, nearly 17 % of those grouped as high mobile do so. Higher mobile individuals develop a 'modal competence' for all transport systems they are using and are therefore more familiar with them. This results finally in lower mental barriers for using alternative modes.

Further on we find that a person's educational level corresponds with the thinking about mode alternatives. Only 11 % of all people with a primary school education stated that they considered an alternative while 30 % of tertiary educated people do so. Mobile phone ownership and access to the internet: both relate positive to the consideration of modal alternatives. It seems that education and the efficient usage of information is an indication for open mindedness in modal choice processes.

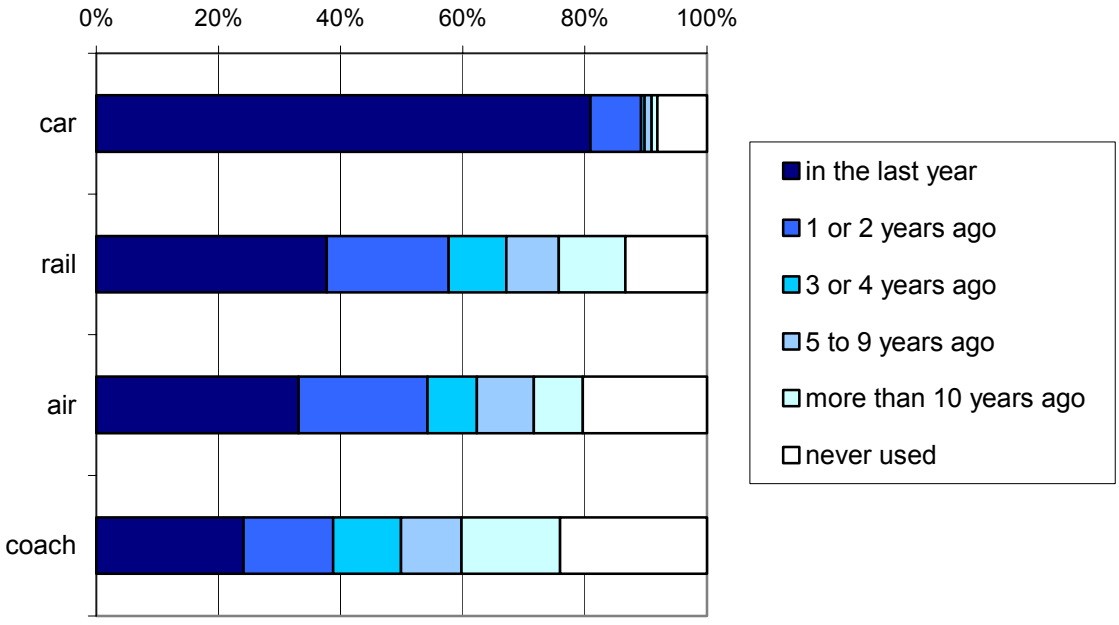
The conclusion may also be supported by the fact that younger people seem to be more flexible than older ones, 34 % of those aged 14-29 "choose" while only 13 % of those being 60+ years old considers alternatives. This finding might indicate that "learned" habits gained importance during lifetime and substitute rational decision making over time. Thus, behavioural flexibility reduces when individuals becoming older and habitualness rises.

Not surprising is the highly significant finding that people living in rural areas rarely consider additional alternatives when planning a journey. A probable reason is the worse accessibility of public transport in dense populated regions which provokes the usage of private cars and might leads to a kind of habitualness in mode choice in the longer run.

A summary out of this could be that young, well educated and mobile individuals show the highest potential for the use of alternative modes or of possible integrated services. This group of travellers could be seen as innovators new services for or multipliers for new ways of using existing infrastructure.

As mentioned before two other survey elements are existing. The one on 'innovativeness' is yet still in the field and therefore not available but should provide indications which types of traveller are more innovative than others and might therefore test new travel supplies more open minded. We made also preliminary analyses on the data of the other just finished element named 'modal orientation'. This should give some hints which modes are preferred by a specific type of traveller and which ones are rejected right from the beginning of the decision making process due to individual preferences.

Figure 3 Time period since last use of certain means of travel

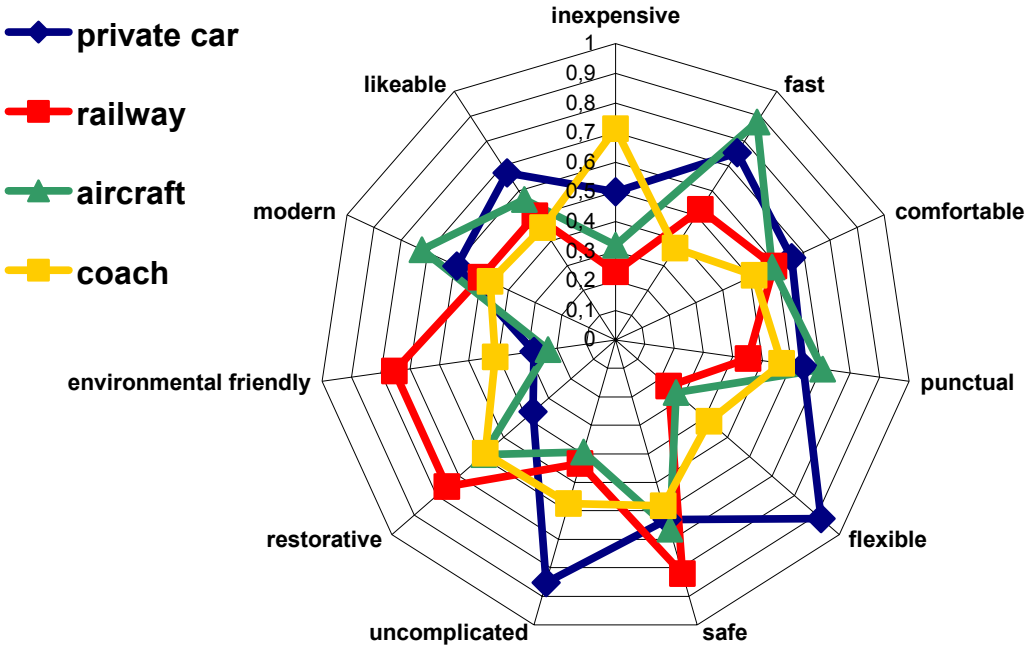


An analysis of mobile individuals shows that people have very different levels of experience with certain means of long-distance travel. Figure 3 depicts that using a car is very usual. In the last year period more than 80 % of the population used a private car but only 38 % a train or 33 % an aircraft. Every eighth traveller has never used a train while only every twelfth never used a car in long-distance travel. This means that the ability to use a car is generally more widespread in the population than the competence to use the railway system accordingly. This further indicates that modal (and also intermodal!) barriers exist uneven in the population and decision making will therefore be far away from the ideal form assuming full choice sets for everyone.

We asked the respondents to value the importance of eleven criteria with respect to certain trip purposes. Following the given answers, business journeys require transport modes that are (in decreasing order of relevance) punctual, fast, safe, flexible and uncomplicated. For private

purposes a mode should be safe, inexpensive and flexible, while it should be safe, uncomplicated and inexpensive for holiday journeys.

Figure 4 Characteristics of different means of transport in public opinion



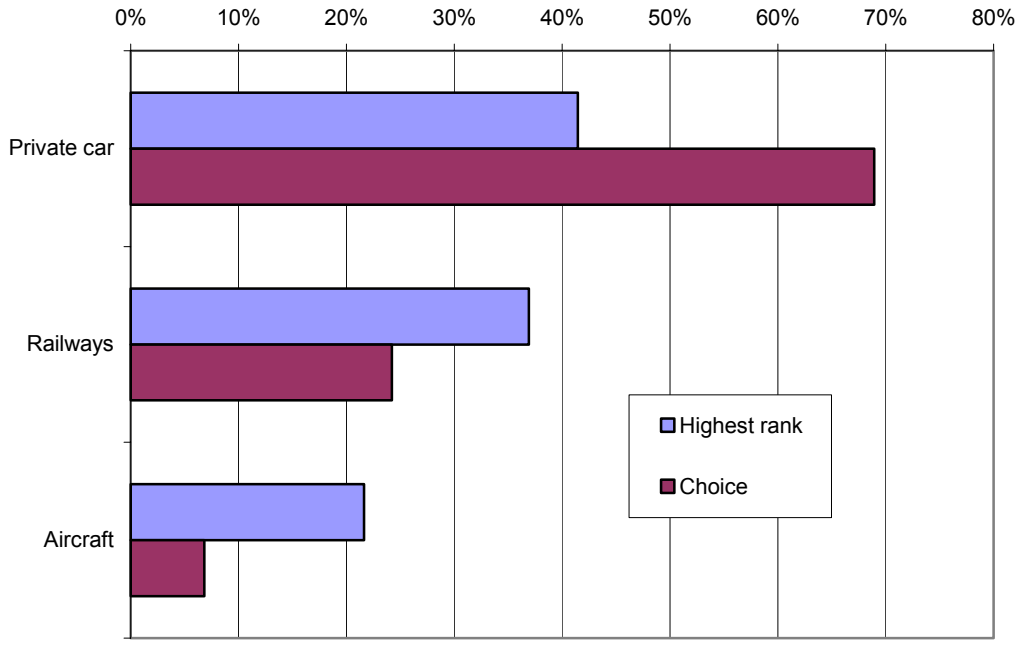
To answer the question which means of transport meets these requirements best, we also asked to what extent a given mode fulfils these attributes. The set that should be valued by the respondents comprises (private) car, railway, aircraft and coach. For each attribute the respondents should indicate whether it is absolutely, somewhat or not applicable. In a cross-sectional analysis general patterns appear that characterise a means of transport in public opinion (see Figure 4).

The railway is considered the most inflexible and the most expensive. Its advantages are safety, environmental friendliness and restorative travelling – good arguments for a holiday journey. Although the railway is considered to be nearly as inflexible as the aircraft, the aircraft dominates in the issues punctuality, fastness or modernity, further on air transport is regard as quite safe and comfortable. Thus, it is the most appropriate mode for business trips. The car that is the most flexible, the most uncomplicated and a quite fast mode for travelling in average mind. This correlates very much with the overall requirements for private journeys.

In contrast to cars railways are considered generally as inflexible, quite complicated and much slower. We were interested to decompose system-related from other choice determinants, i.e. situational and personal. When we look at e.g. German domestic private journeys with a one-

way distance of 500-700 kilometres then we see an actual modal split of car 66 %, railway 26 % and aircraft 8 %. In the survey we asked the participants to rank the modes – given that travel costs and times are assumed to be equal, so theoretically the resulting ranking should only be influenced by non-system-related criteria.

Figure 5 Asymmetry between modes by ranking and by market share



Under the assumption that only situational and personal factors matter, private cars will be the first choice for only 41 % of all respondents, railways for 37 % and aircrafts for the remaining 21 %. The railway's potential (e.g. being suitable for a specific trip purposes and having a positive image) seems to be much larger than the market share realised, it appears as 11 percent points are 'lost' in the considered market due to higher costs and travel times. Figure 5 depicts the different share between those modes ranked highest and those actual chosen.

Usually we would conclude that improvements in average speed or lower prices will rise the market share of rail. But the heterogeneity in individual perception might cause that also significant changes in the system will not be effective. A prominent recent example: German Railways advertised its new pricing system to result in an overall reduction of ticket prizes.

Despite the simultaneous upgrading of a core link[12] in the German rail network, the demand measured in kilometres travelled decreases in 2003 by 7 % with respect to previous year's first quarter[13].

On the other hand, referring to the hypothetic situation in the INVERMO survey, only 59 % of those respondents that really travelled by train, voted railway as first choice, while 22 % train-users stated that they preferred private car and 19 % stated that aircraft was their rank number one. The latter share might be forced to switch to rail due to high prices for comparable flights but the previous having a preference for private car used railway when comparing the expected utilities of both alternatives. With respect to the above mentioned dominance of private car characteristics for private trips, it would be very interesting to know exactly which reasons caused the choice. Unfortunately we have to rely on an revealed preference approach in this situation.

6. Conclusion

The INVERMO project collected information about determinants of modal choice. Furthermore the survey data allows a profound view on the structures of long-distance travel. Besides an unbalanced distribution of long-distance mobility in the population, the analyses reveal different types of journey contexts and variations in choice behaviour within the population. Altogether these findings result in a new complexity of long-distance travel demand.

Our findings illustrate that time, costs and comfort might not be the only relevant determinants in modal choice. However the determinants can be clustered in three items: system-related, situational and personal. Because classical approaches often only consider just one of these clusters, their results can be misleading. Although, the intention to use an extended set of decision making determinants also causes problems.

Modelling concepts in this field are normally based on macroscopic approaches. Thus, the sound implementation of personal- and journey-specific attributes is difficult because macroscopic models usually refer to trip volumes between zones and do not account for the travelling individual or a journey's context. Consequently simulation models based on these concepts also must be able to deal with these requirements.

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[12] A completely new build high speed link halves the travel times between Frankfurt/Main Airport and Cologne.

[13] Source: Scharrer, Jürgen (2003): Mehdorns Fehler, *Touristik Report*, 13/2003

The INVERMO project includes the implementation of a microscopic simulation model to deal with recent findings concerning travel demand in general and especially the above findings of modal choice behaviour. The model application will allow to identify potential users, to estimate their needs and finally to evaluate market potentials of integrated transport services.

Further studies, additional data and sophisticated analyses are required to reveal the spectrum of choice determining factors – but also appropriate modelling approaches that are capable to handle the resulting complexity.

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