

# Considerations on the design of behavioural orientated models from the point of view of empirical social research

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## TRANSPORT USER BEHAVIOUR AS RESULTING FROM SITUATIONAL CIRCUMSTANCES AND INDIVIDUAL ATTITUDES

Transportation planning was recently defined as the "totality of systematic activities through which future measures are studied and laid down in advance for the purpose of changing specific conditions in the transportation sector in line with planning goals". [1]

What do we understand by "conditions in the transportation sector?" They are certainly not only momentary traffic patterns obtained for example from statistics on the volume of traffic. On the contrary, we must proceed further, particularly if future conditions are to be anticipated, and examine the causers of traffic phenomena and their reactions to changes in their environment in the broadest sense of the word, i.e. study individual persons and their actual transportation behaviour. Measures initially affect only the constraints of behaviour and therefore changed conditions in transportation result only from the summation of subjective changes in the behaviour of individuals on those changed constraints.

Accordingly, reliable prognosis is only possible when individual behaviour is inferable, i.e. explained from given situations. If the determinants of the subjective assimilation of environmental influences are known, it can be assessed how specific users will react to modified conditions in which way. The clarification of such operating mechanisms should therefore be an important task of basic research in the transportation sector. This paper attempts to stimulate efforts in this direction from the viewpoint of social science.

## BASIC APPROACHES TO TRANSPORTATION PLANNING MODELS

Without claiming to be exhaustive, the following section will briefly review several historical lines of development in the conceptions of transportation planning models. This would seem to be necessary for several reasons. On the one hand, some of these lines of development have - so to speak - taken an autonomous course, i.e. they have been refined and elaborated to such a degree that discussion of their internal partial problems largely only takes place within a narrow circle of "initiated" experts, with the result that frequently a critical examination of the basic assumptions of these conceptions is no longer undertaken. Many pronounced mathematical approaches, be they of econometric origin or developments of traffic engineers, are particularly exposed to this danger. This detailed discussion shall be left out of our considerations because - as will be established

later - it can be partly viewed as irrelevant to the goals of transportation planning.

On the other hand - and this is considered to be more important - a development could be observed in recent years which seemed to make a positive effort to include the social sciences, notably sociology and psychology, in transportation planning models. Key words here are disaggregate and attitudinal models, which - as Heggie [2] aptly observes - are currently shooting up like mushrooms. But viewed against the background of the following attempt to adopt an approach actually orientated to the real behaviour of individuals, in several cases the suspicion can not be dispelled that it is a question of misunderstanding or mere fashionable terminology when long established approaches are furnished with additional components or exponents and suddenly renamed "behavioural models". It must therefore be made clear what demands are to be fulfilled by models which not only describe but also explain individual behaviour, thereby opening the way for prognoses.

The decisive points of this necessarily abridged discussion of transportation planning models are the type and number of variables, the operation mechanism and the structure of the models.

Initially, strictly descriptive approaches were developed by using means of spatial aggregates as independent variables in regression analysis. These approaches based solely on the empirical proof of more or less even covariation of traffic and land use data. Proceeding analogically from physical-mechanical laws (gravitation, entropy, etc), such approaches were also given the status of "laws", but their basis was generally formed only by common-sense assumptions (e.g. the role of distances) instead of theoretically based validity investigations of the influence factors and operating mechanisms employed.

It was not long, however, before the constructors of these models also began to express a feeling of uneasiness over results that were often not really appropriate, which led to at least a verbal demand that more attention should be paid to the actual causer of observable flows of traffic - namely to the individual. This happened at a time when the concentration of urban and transportation planning on motorised private traffic was felt to be abandoned. Accordingly, it was no longer tenable to use motorisation as the virtually exclusive and decisive variable in the models.

At this point in the development a massive engagement of the social sciences should and could have resulted, for the analysis of fundamental determinants of human behaviour and the development of methods for the empirical acquisition of behavioural data clearly lies

within the scope of sociology. The (small) circle of professional transportation planners who realized this and tried to obtain appropriate support were often just as disappointed as the (few) sociologists who wanted to take an active interest in the problems of transportation planning. The engineers made hurried demands for handy and exact prognoses of human behaviour over extended periods of time, whereas the social scientists began by stressing the necessity of developing a sociological theory of traffic behaviour, and for scientific reasons rejected the "muddling through" of the engineers. There are still considerable difficulties of communication between the two disciplines.

Subsequently, a relatively indiscriminate search set in for factors which, due to diverse opinion surveys or the personal convictions of individual researchers, were thought to influence the traffic behaviour of individuals.

This resulted, for instance, in the development of a category of models on an econometric basis whose basic assumption was a rationally behaving, completely informed individual primarily orientated to economic criteria. By means of various combinations of numerous variables utility functions were formed, which, for example, were intended to depict individual preference with respect to alternative transport facilities. By using the utility functions in logit - or probit - approaches, it is then possible to calculate individual probabilities relating to the occurrence of journeys, modal choice, and the spatial distribution of the journeys.

A basically different approach was taken in the Federal Republic of Germany by Kutter. [3] Starting from the basic needs of people, he used a schema adopted from sociological theory for the causal explanation of behaviour patterns. According to this schema, a person's sociodemographic characteristics determine his status, and from this a specific role behaviour with specific activity patterns can be traced. This concept led to "homogeneous behavioural groups" which were also able to be proved by empirical-inductive method. Höttler [4] has quite rightly noted that new ground was broken here to the extent that an attempt was made to classify individuals according to their respective environmental situation and to explain their patterns of behaviour in the context of these situations. Thus, whereas, there is a danger of the (roughly described) econometric models chasing after an artefact with their basic assumption of a "homo oeconomicus" and a considerable expenditure of mathematical effort, Kutter's models based on homogeneous behavioural groups arrive at their statements via strictly deterministic lines. It would appear doubtful, however, whether the alleged stringency of the chain demography - status - role - activity pattern - transportation pattern corresponds to real conditions. This implies quite clearly an overtaxing of the role theory. Kutter has partly noticed these limitations himself and qualified the validity of his model with respect to chronological and spatial applicability.

If we look for the reasons for the shortcomings exhibited (to a very varying extent) by previous models, the following can be observed:

- The constructors of models have frequently submitted far too readily to the pressure exerted by users of transportation planning models for quantitative prognoses. Even in cases where specification of the scope (of possible behaviour patterns or of traffic volumes) would be totally adequate, it is attempted to dispel all doubt about the effectivity of the model employed by emphasizing a would-be accuracy.

- A relatively "blind" application of methods developed in natural sciences and economy to causal social phenomena avoids the necessity of having to grapple with complicated facts which are difficult to express in

mathematical-formalistic terms, and are found to be infinitely variable and hardly susceptible to systematization.

- The fascination held by "exact" methods in connection with large computer capacities, encourages the neglect of all variables that can not be quantified at all or only with difficulty, and occasionally leads to the fading-out of entire segments of reality. Accordingly, highly complex model systems with an extremely high degree of descriptive accuracy are designed without checking their *explanatory value*.

- The lack of an easy-to-use, directly applicable sociological theory of transport behaviour encourages the disregard of relevant psychological and sociological research findings.

- A general approach to transportation behaviour as a mass phenomenon loses sight of the individual who acts from within his social context. Behaviour patterns in traffic (as in other spheres of life) are, however, neither solely the result of rational utilitarian considerations nor the product of wholly determined behavioural roles.

This is, of course, a simplified representation and has been partly superseded in several new approaches. As far as we can see, however, general practice is still based to a very large extent on the inadequate assumptions described above.

## EMPERICAL FINDINGS

### **Empirical examination of the assumptions entailed in the models**

To avoid constantly new - artificial - impasses in the search for practicable transportation behaviour models, it is therefore imperative to reflect back on the causers of traffic.

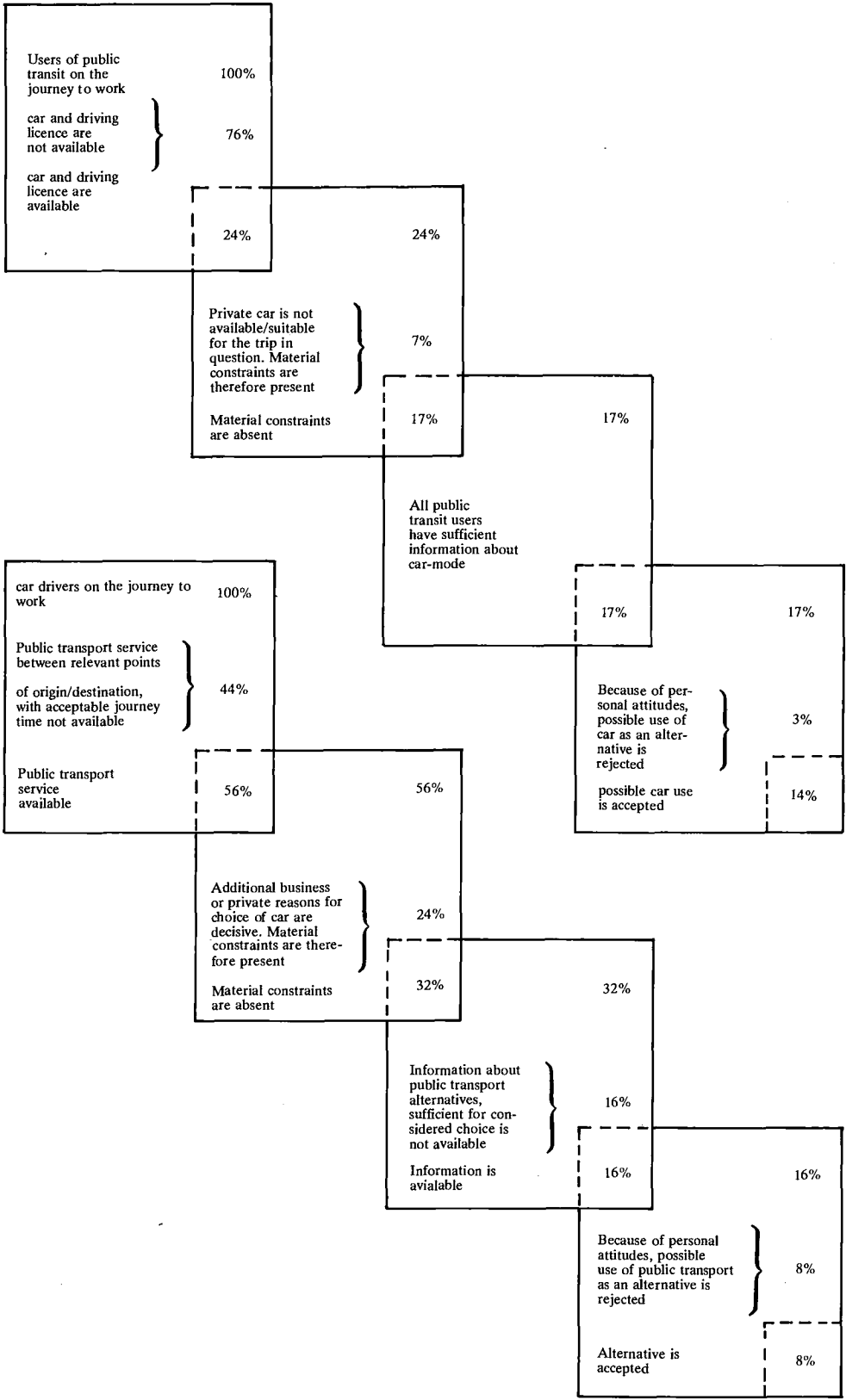
In order to be able to recognize the "goodness" of a model approach, it is thus necessary to establish if this approach is capable of explaining individual decision and behavioural sequences. In many cases, the simplest empirical examination suffices to show that this requirement is not met and that functional relations are implied in the model which can not be proved empirically.

Before briefly discussing several selected empirical data, we should at least mention at this point that the problems of "empirical methodology" - to a large extent neglected in discussions among transportation research scientists - plays an essential role here. We shall return to this question later on.

For a number of reasons, this brief digression into the subject of relevant empirical findings shall concentrate on a small selection of essential results. A detailed discussion of the abundant material available is beyond the scope of this paper. We also feel that a precise analysis of all the demonstrated errors of measurement is not necessary to substantiate our hypotheses. We base the discussion of the importance of travelling times and costs - as the most common variables in transportation models - on the results of a pilot study on modal choice in commuter traffic. First of all, 300 gainfully employed persons who travel to work by private car or by means of public transport were surveyed in depth; the results of this survey were fully confirmed by a later survey of 1.200 heads of households in urban areas in the Federal Republic of Germany <sup>1</sup>.

### **Importance attached to travelling costs**

If an investigation is made of the awareness of costs incurred by the respective journeys to and from work, the first thing to be observed is that in neither of the two cases - use of private car and use of public transport - a clearly quantifiable result can be obtained. The reason for this is that in calculating the private car costs it is by no means clear what items - apart from the cost of petrol



used - should be entered into the calculation, and in ascertaining public transport fares the varied possibilities of daily, weekly or monthly tickets has to be taken into account. Thus, while the results obtained do not furnish an exact insight into the individual's precise knowledge of costs, this is furnished with respect to his awareness of costs (and its role in modal choice) which is, however, quite sufficient for our purposes - the examination of the relevance of "economized" model assumptions.

For example, a good half of the car users surveyed were unable to supply an answer to the question of what their car costs them per kilometre; a similarly large proportion had never even considered what costs were incurred in driving their car to work.

The figures supplied by the rest of the drivers surveyed are systematically too low; the supposition that by no means all of the relevant cost variables had been taken into account only partially explains this phenomenon. It can be directly concluded from this that the real costs can only influence modal choice of transport in very rare cases, or - in other words - there is no proof of a cost-utility decision on the factor travelling costs.

This statement gains considerable support when we include the knowledge of the costs of the (real) alternative of public transport. Only about half of the car users surveyed could accurately state the price of at least one type of fare; only one in ten knew the costs of weekly and monthly tickets, which are relevant to commuter journeys. A similar picture results from the investigation of public transport users (who, per random sample definition, could also use a car if they wished): on an average they knew the costs of at least two of the four possible types of fare in public transport, but only one in four could state the per kilometre cost of his own car. This proportion increases in the case of the question of the real cost of a journey by private car to work. Analogous to the car users, about every second public transport user supplied a cost estimate, but - in contrast to the car users this information shows a considerable overestimation of the costs actually incurred. This means that an economic functional relations - assumed in many models - can not be proved, and also that the real awareness of the individual is so emotionally and irrationally distorted that it counteracts the considerations assumed in the models.

### Estimation of travelling times

Quite similar results are obtained in the subjective estimation of real travelling times: the subjectively estimated travelling times tend rather to express justification for the chosen mode of transport than to indicate that preference has been given to one mode of transport on the basis of rational consideration of alternatives. For example, car users systematically underestimate the actual travelling time by car and systematically overestimate the times of alternative journeys by public transport; the share of estimates that are approximately correct is remarkably low, accounting for only one third; about every seventh car user has given no thought whatsoever to the real time he takes to drive to work. The information supplied by public transport users is just as remarkable: they overestimated the travelling time of their "own" mode of transport by a good quarter - although they use it daily.

These results illustrate quite vividly that the individual transport user can not be credited with making rational decisions based in time and cost considerations. The variables control individual behaviour at the most indirectly and by no means always rationally - which is naturally specially important when designing planning measures.

Accordingly, quite obsolete results can be expected if,

for instance, information on travelling times is expressed in terms of cost variables, as done in many cost-utility studies. Since this involves systematic, non-random false estimates, accumulations of errors result.

### "Complete" information

With this, we have touched upon a further important prerequisite of economic models, one which partly proves to be an unwarranted assumption: the assumption that the individual is fully informed about the concrete system of his environment.

In the investigations referred to above, we stated that only those car users were surveyed, who could also travel to work - in comparable time - by means of public transport. Just under half of these car users were totally unaware or very scarcely informed of this possibility. Frequently, car users are as unaware of routes as of stops, and in many cases there is even a total ignorance of public transport connections which are more convenient with respect to time than the journey by car. This means, however, that in the few cases in which time/cost considerations are taken into account it can by no means be assumed that this is done on the bases of the variables offered by the objective environment; on the contrary, this environment is first filtered through the subjective information - a process which in any case would have to be accounted for in a corresponding model approach.

### Influence factors relevant to behaviour

This observation, however, takes us back to the beginning of our considerations, back to the requirement that observed behaviour has to be explained first before it is represented in model form and prognosticated.

This step becomes possible when a theoretical concept and a set of methods are available for its empirical realization. Both prerequisites will be discussed in greater detail in the following sections. Nevertheless, we should like to refer in advance to the finding "explanation of modal choice in commuter traffic", in this section on "Empirical findings", for two reasons. Firstly, it can be shown that it is actually possible to establish empirical explanations for behaviour. On the other hand, an impressive demonstration can be given of how many well-known transport behaviour models (necessarily) ignore simple and perceptive relations and what possibilities of explanation and prognosis they lose in doing so.

If we consider the above mentioned representative survey of households in urban areas, the following picture is obtained: (see page 224).

It is obvious that this is still a rough classification which could be refined further, but it is equally evident that it offers explanations which are convincing and actually determine human behaviour. The key to these explanations is evidently the respective individual situation on the basis of which behavioural choice is made. This conceptual approach will be taken up in the next section and considered in greater depth on the basis of several sociological considerations.

### SOCIOLOGICAL DIGRESSION

In the historical development of sociology we find many attempts to comprehend the "social complex society" theoretically as a whole. Such attempts, made, for example, in the theories of functionalism, or - more generally - in the systems approach, are characterized by the fact that their propositions have to be made in a kind of generality that is no longer commensurate with individual subsystems.

This theoretical direction has been significantly enriched by Herbert Spencer, who defined modern society as a social organism in analogy to biological systems. This strictly "biological" thinking was soon abandoned,

but not the system thinking per se<sup>1)</sup>, which among other aspects returns in various theories about roles and role behaviour in refined form. Parsons' structural-functional theory of society must be placed in this category, which endeavored to establish a logically integrated theoretical system of principles, concepts and laws in order to be able to describe and explain the functional connections of certain segments of society with reference to empirical elements.

Even though these system theories were improved and refined in many respects, they were able only to deal with overall problems of the whole, but could not make any detailed statements concerning its parts [5]. But the whole is different from the sum of its parts, as the ancient philosophers already told us.

Other parallel theories in sociology defined behaviour as the resultant of the entire individual habitat. They are based on philosophers like Georg Simmel, who understood the individual as an intersection of overlapping circles, whose spheres of influence determine his behaviour and thinking.

The continuation of this line of thinking [6] is characterized by the effort not to deduce social relationships from a model of the entire society (regardless of the nature of this model), but to conclude quasi inductively from individual situations to typical behaviour patterns. The total social structure of society is then the result of a generalisation of individual behaviour.

By interpreting each specific individual as an actor in a specific situation, it is possible - in contrast to system thinking styles - to consider also informal or formally not established processes.

On the other hand this approach requests to regard individual behaviour patterns only in the context with others and with the environment generating them. The situation in which the person finds himself, is defined as the entirety of the factors influencing his behavioural reaction.

This entirety is determined first of all by variables of the material environment and the overall social situation, but also by factors determining the individual himself. Accordingly, "the overall situation always contains more or less subjective factors, and the behaviour reaction can therefore only be studied in the general context, i.e. both the existing situation (as it can be objectively examined), as well as the situation as it is regarded by the person concerned, must be investigated" [7].

From this theoretical viewpoint the real causes for human behaviour with their specific individual complexity and also the changes in behaviour can be estimated. They take place whenever the parameters determining the individual situation are replaced by new ones.

This idea has been even further differentiated by the authors cited above. Without stepping into greater details on these (in some cases important) refinements here, three essential advantages - particularly with respect to its transfer to planning models - remain to be noted:

1. It proceeds from a simplified cause-effect relationship and asks: in what situations do individuals react with which behaviour?

2. It designates the variables of behaviour by studying behaviour patterns in various situations.

3. It demonstrates the necessity of comparison groups in order to be able to measure the significance of single parameters by comparing the behaviour of different individuals in varying situations.

This means that future model constructions must get away from thinking in terms of aggregates, because otherwise important individually oriented parameters of the decision process will be neglected in favor of the

theoretical assumptions constituting the specific system concerned.

#### A SOCIOLOGICALLY-ORIENTATED APPROACH TO EXPLANATION OF MODAL CHOICE BEHAVIOUR

An attempt is made in this section to incorporate the basic concept of thinking described above in a model of behaviour in modal choice of transport. There can be no question at present of obtaining an absolutely flawless, directly applicable model. Before a final formulation is possible, a series of fundamental investigations are still necessary, which partly have already got underway. There are several results available, however, which not only serve to illustrate the path taken here but can also provide evidence for the practicability of the approach.

As we have shown, the prerequisite for this type of model is a thorough knowledge of the individual situation which leads to the respective mode of behaviour.

The example treated here - modal choice between private car and public transport in commuter traffic - has already indicated that a situation of option can be essentially determined with three basic dimensions:

- supply of transportation alternatives
- socio-demographic determinants
- subjective attitudes

The individual situation of option is defined by various factors from these basic dimensions according to their form and combination. Under supply of transportation alternatives we understand both the availability of public transport (for travel from home to work) and individual transport facilities (possession of driving licence and car).

On the other hand, the socio-demographic determinants - represented here by so-called material constraints - frequently limit an objectively existent situation of option. Examples of material constraints for the use of private car for journeys to work are:

- the necessity of using the private car at work; in this case, it is the car that is "transported" to the place of work and not the driver. The most striking examples are persons who need their car as a "tool of their trade", or who are not tied to one particular place of work;
- irregular working hours at the place of work which either prevent or make use of public transport difficult; this applies in particular to weekend, night and shift workers;
- The necessity of performing extra activities at work or on the journey to and from work; this is typical for households located in an area with a lack of infrastructural facilities, as well as for gainfully employed persons who for family reasons are obliged to reduce the hours spent away from home to a minimum;
- the need to take along additional members of the family on the way to and from work, in particular when children are driven to schools or to kindergartens and adult members of the family to their places of work;
- health reasons, especially physical disabilities which make use of public transport very difficult or impossible.

The two main material constraints making for the use of public transport are:

- the (in principle available) family car is already being used by other members of the family;
- there are no suitable parking facilities at the place of work<sup>2)</sup>.

It is obvious that these material constraints are not all of the same importance. "Hard" material constraints which are impossible or extremely difficult to evade are to be distinguish from "soft" material constraints which allow freedom of action to be gained by making new arrangements within the household. Attempts are currently being made to incorporate such a differentiation

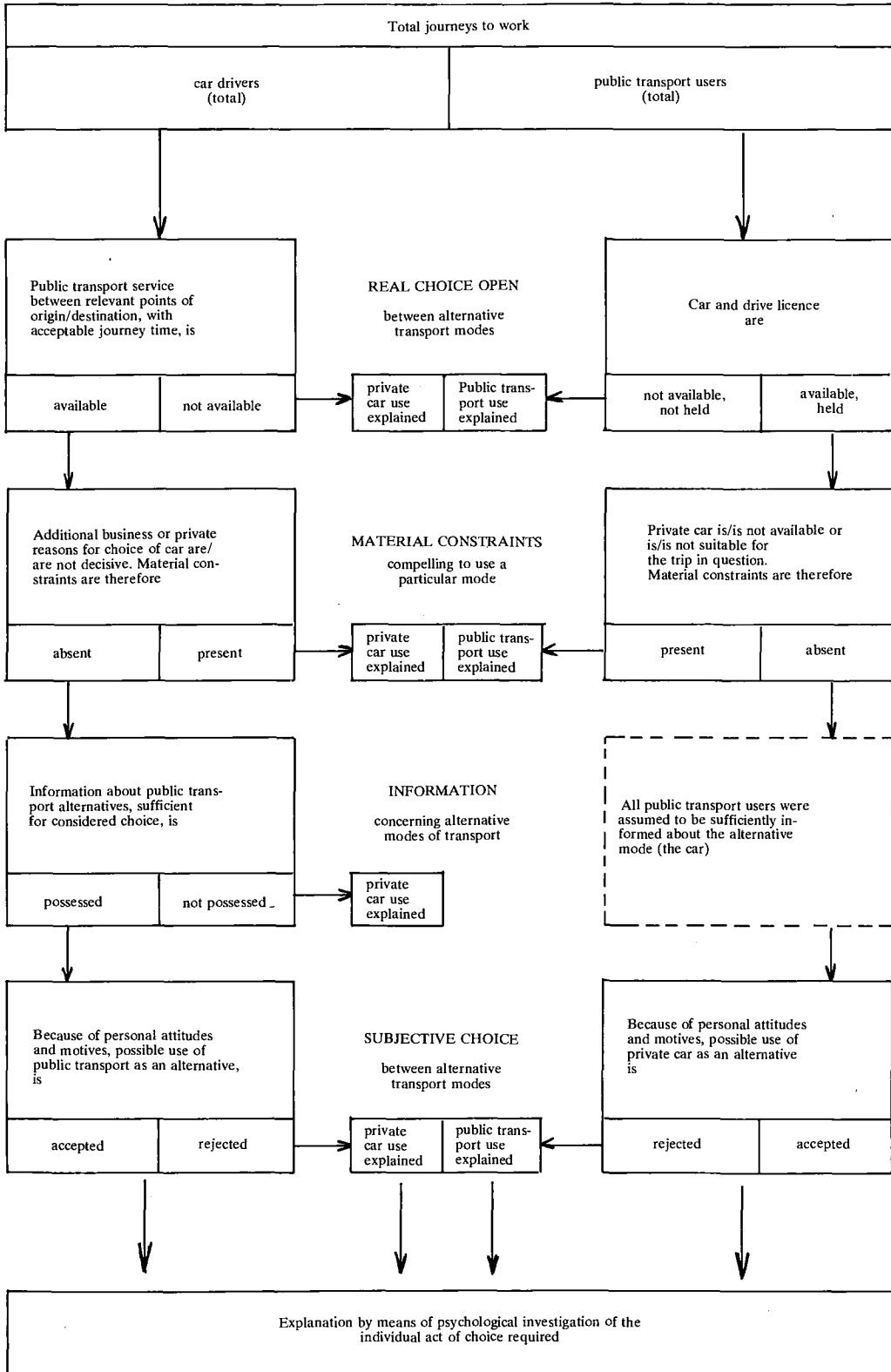


Figure 1 - Explanation of modal choice by reference to individual situations of option

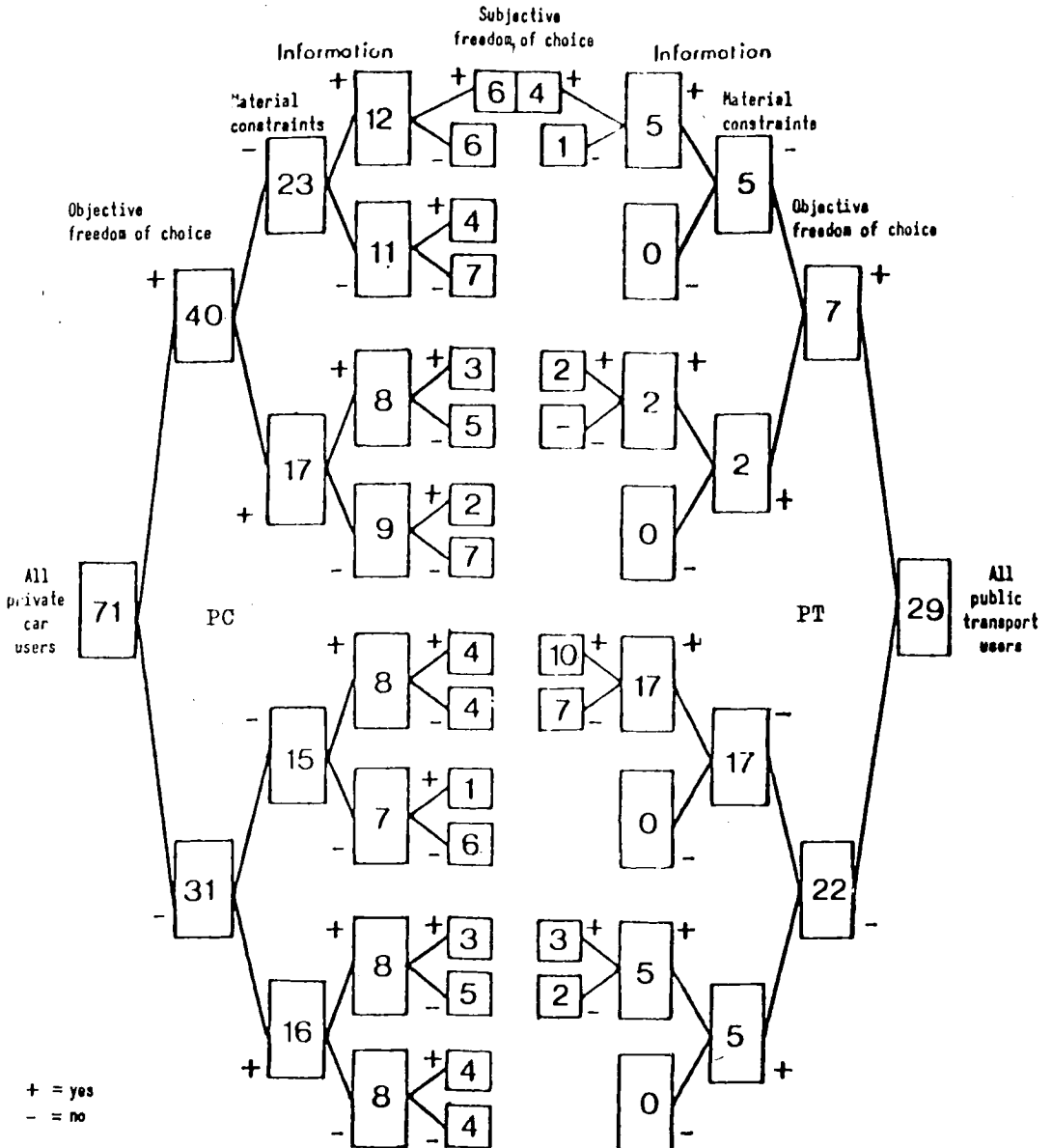
in the model, with special consideration being given to the possibilities of substitution (e.g. transfer of activities to other members of the household).

The third and no less important dimension is that of the subjective attitudes. It must first be ascertained if these attitudes are actually materialized on an adequate basis of information. As already shown, a large proportion of traffic participants are so badly informed about objectively available alternatives that a subjective situation of choice does not exist for these individuals.

Knowledge of the available transport alternatives is thus a constituent feature of the situation of option. A role is also played in this dimension of course by the

influence factors which - being difficult to objectivize methodically - determine the subjective preference for one or the other alternatives. If we combine all the factors influencing choice, two groups of persons exercising choice can be formed. The first group regards both alternatives as possible choices - i.e. perceives a subjective possibility of choice - while the second would choose only one of the alternatives because of personal attitudes.

To sum up, this means that for the description of the individual situation of option it is thus necessary to establish for every individual whether it



Figures in %. Based on 1,200 answers to an opinion poll in connection with KONTIV 1975. Representative of heads of households in urbanised regions of Germany.

Figure 2 - Model of situations of modal choice: quantitative form

- has an objective possibility of choice,
- is subject to material constraints,
- is adequately informed about the objectively available alternatives, and
- considers all alternatives to be subjective possibilities of choice or not.

Figure 1 represents this system for modal choice between private car and public transport in diagrammatic form.

This system was initially conceived as an explanatory model for the genesis of modal split - modal split being considered as the result of decisions taken in the various individual situations of option.

In the combination of the situation of option defined by objective and subjective constraints, two partial structures - mirror images of each other - emerge for car drivers and users of public transport which enable every individual decision to be assigned to the corresponding situation of option. This presupposes, however, that the corresponding objective (e.g. transportation facilities, travel times, household structure) and subjective (amount of information, personal preferences) parameters have been individually surveyed using adequate methods.

Figure 1 clearly shows that causal explanations for the modal choice of certain individuals can already be detected in every stage of the decision making process: situative conditions act as a constraint making for the use of a specific mode of transport. The individuals concerned are consequently no longer responsive to planning measures which do not aim at these limiting conditions exactly. For instance, reductions of fares or travelling times in public transport are irrelevant for those individuals who don't have any public transport facilities on their origin/destination route, or who are dependent on the use of their car at work due to professional material constraints.

On the other hand, it now can be determined which individuals gain new options if certain planning measures take place. Then it is possible to conclude by analogy from persons already having been in such a situation of option to the changes of behaviour of those people, who are new in this situation.

This is an important step towards the formation of a policy-sensitive model, and which in our view fulfils an essential requirement in such models, namely easy application and maximum clarity.

In Figure 2 the model approach is drawn up in quantitative form on the basis of the results obtained from the study of commuter traffic mentioned above. Each individual person was analysed in his respective situation and assigned to a group so that the groups affected by specific measures, for example, can be easily identified.

Obviously, this is a simplified computation; as yet only parts of the work have been carried out on an exact formulation, which is conceivable in a number of ways. Moreover, it will be necessary to make a closer examination of differentiations, feedback and dependencies in the system of the model planes.

What can be shown, however, is not a finished prognosis model but a fundamental mode of thinking. This mode of thinking finds expression, for instance, in the fact that anticipated changes in behaviour are not read off a function for aggregates but the actual process of decision is "recreated" by addition of each of the individual changes in behaviour. This is possible because the model preserves the homogeneity of the individuals and takes account of the scope of action determined by formal and informal, objective and subjective factors. A conceptual approach of this type is consistent with the sociological considerations outlined. It is limited merely by the possibilities of acquiring sufficient empirical data.

### Empirical data requirements

Models which are orientated to individual behaviour and the individual situation impose other demands on the respective initial data and in consequence on the methods of empirical social research as usual in the transportation field.

Contrary to the general view, a number of these requirements can be fulfilled if the empirical survey methods are conceived to be an integral component of a scientific discipline (sociology) in just the same way as chemical experiments are in chemistry.

These considerations, however, must focus on the individual as an indispensable source of data. Accordingly, it is primarily a question of employing survey instruments that are attuned to the individual.

The set of instruments, therefore, should not be determined predominantly by the technical demands - whatever form they might take - of a theoretical-formalistic mechanism of reproduction of reality; empirical survey methods should be determined by research conceptions and not vice-versa.

It should be quite clear that in a scientific discipline as young as empirical social science by no means every methodical possibility has been developed and tested. Accordingly, the development of suitable models in transport research will also be determined by a readiness to engage in basic empirical research. Transport research scientists, who constantly employ empirical data, could perform a decisive initiating function in this context.

Two fundamental aspects should be considered when discussing methods:

- the problem concerned
- the methodical procedure

The first aspect involves the question whether - proceeding from the consideration that an "all-embracing" survey method does not exist - the respective procedure is adequate for the problem to be investigated. The second aspect concerns the practical realization within the process of research, which is generally discussed under the concepts of validity, reliability and objectivity.

As a rule, discussions of method tend to focus on instrumental questions, i.e. they are orientated to the second aspect. It is, however, of fundamental importance for the survey method to be properly orientated to the problem concerned, as this simple consideration shows: According to the comments in the previous sections, a given mode of behaviour is determined by a quite specific constellation of variables: the respective individual situation. This situation is experienced subjectively by an individual and constrains the freedom of action and decisionmaking sequences. An empirical determination of this situation thus requires - in simplified terms - data relating to the material environment, the demographic structure of the individual and his household, and subjective attitudes and evaluations - which are determined by society and its reference groups, as well as by the individual personality structure.

Generally, it is inconceivable that all these data can be acquired via a single empirical measurement. It is still more inconceivable, however, that a demographic enquiry into these data can supply an exact picture of all these variables, for the demographic enquiry serves to determine subjective opinions. In our example it determines, at the most, the individually experienced but not the actually existing situation.

This is not to say that it would not be important to determine this subjective description of the situation, but it should only be taken as one form of information



among several others; otherwise, a realistic analysis is not possible.

As a rule, therefore, a problem-orientated empirical procedure will not manage without different, strictly co-ordinated, survey stages. It must always be borne in mind that not all the required data can be directly surveyed.

In the case in question, it is certainly not (yet) possible to comprehensively measure the actual cause of behaviour - the individual decision. Accordingly, it is necessary to survey as accurately as possible the actual behaviour as the direct result of individual decision, and to put these data in the original context of the respective individual situation.

In addition to a survey of the individual behaviour, it is necessary to acquire

- "secondary statistical" data on the infrastructural environment

- demographic data of the most diverse type
- dimensions of subjective attitudes.

Methodical problems arise here mainly with respect to the measurement of the individual behaviour and the dimensions of subjective attitude. While the importance of the second sphere is often overestimated - as shown such variables only take effect in a small section of the individuals - the problems involved in the first are often underrated.

As we are unable to do more than just touch on a few important problems here, we shall report briefly on our efforts to develop better instruments for measuring individual behaviour. Our work is based on many years of basic research, which will be published in detail elsewhere.

### Reflections on the measurement of transportation behaviour

No scientific measuring procedure is able to reproduce an absolutely true picture of reality. This applies in particular to empirical social research, above all because it is frequently dependent on verbal information from individuals surveyed and thus fully exposed to the problem of subjective distortion.

It is mainly the question, therefore, to reduce inaccuracies in measurement as far as possible. This means that in the case in hand it is necessary to make the target group into "recorders" and not into "reporters" of their behaviour. It can be proved, namely, that behaviour patterns described in an interview situation partly deviate quite substantially from reality, whereas the informations recorded in diary form possess a relatively high degree of accuracy.

Some of the most important reasons for this are:

- The enquiry into behaviour is always an inquiry into the subjective appraisal of behaviour, an effect which can be minimized in the case of diary usage.

- The survey situation "interview" creates special situative factors which influence the responses. The persons being interviewed report - unconsciously (memory problems) and consciously (a "stranger" vis-à-vis the interviewer) - significantly less activities (ca. 10% - 15%) than they are willing to record in diaries.

- The interviewer is not the "soulless being" he often attempts to be, but an elementary component of the act of communication. This influence is considerable and has been proved in a large number of - largely social-psychological - experiments.

If, in line with these considerations, we decide in favour of a written survey we can expect to encounter two frequently mentioned difficulties:

- The problem of observation of answering instructions

- The problem of the readiness to answer

Today it can be shown in both cases that the misgivings

often expressed in the relevant technical literature are unfounded or quite false.

For instance, the advantages of the written survey for the target persons are so considerable (e.g. choice of the most convenient time for completing the questionnaire) that the instructions for filling in are mostly kept concise. Two examples serve to illustrate this:

- In a survey addressed to only one *specific* person in each of the households covered, this instruction was correctly observed in over 90% of the cases.

- Set day surveys were also filled in correctly on the day specified in over 90% of the cases.

In both cases, the results would more than do justice to a (verbal) interview survey.

The one-sided orientation of the relevant literature is even more obvious with respect to the problem of readiness to answer. Whereas in the social sciences one reckons with a rate of return of 30-40% in written surveys, and while some transport research scientists recommend to be satisfied at a rate of 25%, we regularly obtain a return between 70% and 80% (with a current total of ca. 300.000 cases!). These figures are higher than those generally obtained in comparable verbal surveys. This also indicates that adequate orientation of the survey methods to the problem involved is appreciated by the target group of persons.

This is, however, only possible - and we emphasize this - if the measuring instrument, the questionnaire, is designed with the utmost skill. This brings us to an aspect of survey activity which is still badly neglected today. One must bear in mind that pure variations in the questionnaire design (with identical survey topic) can cause differences in returns of up to 40%, and different questionnaire lay-outs can double the number of wrong entries. This demonstrates the extent to which the quality of empirical research depends on the insight that questionnaires are scientific measuring instruments, and as such can only be properly used by trained and experienced scientists.

However, since properly filled in questionnaires and above all high returns can only be achieved by extensive flanking measures, one is often tempted in an effort to save costs to accept lower - but in comparison still high - returns. Such considerations are just as irresponsible as they are dangerous. They forget for instance, that the random sample theory mostly applied in empirical research projects is only valid when information is actually available on every selected individual.

The fact that this requirement is practically never fulfilled should not, however, lead to an uncritical attitude towards the question of returns. It can be proved that returns, particularly under the 50% mark, often furnish such distorted results that it would actually be better to dispense with such data.

At the same time, considerations of the non-response problem are frequently only orientated to data relating to demographic structure. It can be shown, however, that transportation mobility in particular is generally falsely reproduced by incomplete returns even when the demographic structure, which can be checked against secondary statistics, is "correct". Thus, according to our current findings, we must still reckon with an excessive mobility of ca. 3% with a return of ca. 75% and *after* correction of demographic distortions (!). In cases of lower returns these distortions arise in the region of 10% or above, a circumstance which can seriously mislead a planning project.

A number of experimental investigations is still needed in order to bring the development of suitable instruments in this sector to a provisional conclusion. It has been demonstrated particularly in this field, however, that social research - conducted according to scien-

tific rules - is fully capable of keeping up with the theoretical - conceptual development.

#### OUTSTANDING PROBLEMS AND RECENT RESEARCH APPROACHES TO SOLVE THEM

A different situation prevails in the field of empirical measurement of dimensions of subjective attitudes. Public opinion research has just set off on a number of wrong tracks, taken on the basis of - hitherto non-provable - assumptions of a direct relation between opinions and behaviour.

Accordingly, it is also necessary to search for new possibilities and paths in this field, which is only being undertaken in a few isolated cases.

The basic objective here is to make an area of subjective attitudes accessible to measurement which is actually relevant for concrete behaviour.

Promising in this connection appear to be procedures that simulate specific situations which are as real as possible together with the individual. Their importance - and this can not be emphasized enough - does not lie in the production of simulated results which can be directly used for prognosis, however, but in the possibility of discovering mechanisms and attitudes in the simulated situation which actually determine the respective behaviour.

An important work in this field seems to be the "Household Activity Travel Simulator" (HATS) developed by Jones and Dix, which comes close to meeting the requirements needed in a realistic model as laid down by Heggie. [8] Starting from the actual household situation, the procedure acts out changes in the concrete system of the environment primarily with respect to their effects on the time budget of all the household members.

We are currently pursuing a similar approach using a "Grandma-game" which we developed to discover the reactions to restrictions imposed on a household's financial resources. The game starts with an allocation of the household's total income to 18 different budget items. By means of a step-by-step reduction of the total income the members of the household are forced to reconsider and to redistribute their individual items of spending.

This leads to intensive discussion among the participants, which occasionally results in the development of completely new activity patterns on the part of certain household members. The reactions extend from the simple forgoing of weekend excursions, selling the car, to persons hitherto unemployed taking on extra work, and to a change of dwelling place or job. A game leader draws up a detailed record of the proceedings and tapes them for subsequent evaluation.

The records, and the detailed written and verbal surveys which we carried out with the game leaders at the end of a first stage of one hundred household games, show that the participants take the proceedings quite seriously. In some cases, the household members discuss their budget down to the last penny, and come to a decision only after long and careful consideration. It was again conspicuous that a substantial number of the households initially possessed no information whatsoever on how the monthly income was allocated to the

individual budget items. This fact often created an additional game motivation - the persons concerned now wanted "to find out exactly what was going on themselves".

No individual result can be passed on at the moment as the final evaluations have not been concluded. It seems certain, however that this instrument can be used to obtain extensive information on attitudes and opinions relevant for behaviour, within the context of defined situations.

We must emphasize again, however, that we do not intend to use the results of the games for direct prognoses of modes of behaviour resulting from changes in the household budget. In this respect, we differ from the Oxford group around Heggie, who consider it possible and meaningful to replace comprehensive survey by game simulations in a relatively small group of households.

The experimental method described here is only one example of how to acquire "difficult" data. The approach of a situation-orientated behaviour analysis can also be successfully adapted for application in other fields; for example, for the analysis of migration processes or for user behaviour with respect to infrastructural facilities in the broadest sense of the term. Investigations have already started or are scheduled to be carried out in this field of research. Once the basic structure of these processes has been recognized, an attempt can be made to describe them and make them computable by means of mathematical-statistical methods. At this stage, the use of formal methods is quite justified.

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#### FOOTNOTES

1. Both surveys covered target groups which were in a real situation of option, i.e. who could use a car for the journey to work as well as public transport.
2. In view of unfavourable parking facilities at the place of work, use of public transport is also dependent on socio-demographic variables (e.g. no senior position in firm, otherwise right to parking place or rented space in a multi-storey car park).