INTERNATIONAL EXCHANGE OF TRANSPORTATION RESEARCH: SOME METHODOLOGICAL AND ETHICAL ASPECTS

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1. INTRODUCTION

The world of transportation research is becoming smaller every year thanks to more and more intensive exchange of ideas, data, and research results. International forums bring together researchers from different parts of the globe in a search for solutions to problems which are often more "universal" than one would expect considering the different environments the delegates come from. The goal of these gatherings is all the same: progress in transportation research. This progress is easier to achieve when working together, or at least when utilizing the stimulating suggestions and ideas from fellow-researchers. Their experiences and expertise can clarify our thoughts and help us to avoid many potential mistakes in our research.

Thus, the advantages of a world-wide exchange of transportation research can hardly be overestimated. Yet, a closer look at the state of the international transportation research can lead one to the conclusion that different forms of cooperation are far from being fully utilized. There are many factors which can potentially impede the exchange of international research: technical, economical, political, linguistic, methodological, ethical, legal, etc.

The problem is large and very complex. This paper does not attempt to address all its aspects. Instead, it focuses on two, often indivisible, aspects of transportation research: the methodological and ethical. Three stages of transportation research are considered: a) theory development, b) data collection and analysis, and c) presentation and interpretation of empirical findings.

Some of the issues discussed in this paper may be recognized by researchers from different sub-fields of transportation research as "universal" and quite familiar from their everyday practice. However, in order to discuss some problems in sufficient detail, this paper focuses on the field of "urban transportation modeling," which is best known to the author. Urban transportation modeling and planning is a relatively new and rapidly developing field; therefore some problems may be more visible in this research area than in other, already better developed transportation sub-fields.

This paper addresses some issues which seem to be urgent and important, and does not intend to relate to any specific critique of persons involved in this research area. Any reference which potentially can be made by the reader is purely coincidental.

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2. THEORIES: A METHODOLOGICAL AND ETHICAL PERSPECTIVE

2.1 Standardization of terms, definitions and basic classifications

Urban transportation modeling is a new research field. Models were first developed about 25 years ago in order to perform travel forecasts in such metropolitan areas as Chicago, Detroit or London. Since that time many transportation studies and modeling attempts have been made.

The early researchers faced a difficult job: they had to make some basic assumptions, classifications, definitions, etc., often without sufficient empirical background. Not surprisingly, many of these classifications, definitions, model formulations, etc. varied from study to study. Gradually, new information from different studies increased the overall understanding of the research field as well as description of its basic interrelationships.

From those times until today, modeling approaches have gone through a significant evolution. The macroscopic description of the trip totals ("how many?") was gradually supplemented by additional questions about the purpose of traveling ("why?"); and, finally, about the "actors" making travel choices dependent upon their options and constraints ("who?" and "why?"). Rough aggregate approaches were gradually replaced by behaviorally oriented, disaggregate ones.

It is clear that an improved understanding of the phenomena we try to describe, increases the precision of the description. This can be observed in many research fields. In the case of transportation, a study about human travel behavior has to consider: a) differences in the outside home activities of different groups of persons (subject subsystem); b) differences in the geography of the given area and the transportation infrastructure available to fulfill persons' transportation needs (object subsystem); and c) environmental factors such as economy, policies, etc. All three elements can have a lot of influence on the final choices made by the individual. The human population is highly heterogeneous in respect to the outside-home activities and, consequently, travels; cities are different in size, geography, transportaiton infrastructure, etc.; and finally, environmental factors are dynamic and highly differentiated in their influence on different persons in different urban areas.

Therefore, the field of urban transportation modeling can potentially be a good example of the area where the exchange of research results can become particularly difficult. The key problem is difficulty with comparability. The conclusions from a research team from urban area U_1 from the country C_1 in the year T_1 may not have much in common with the transportation analysis made in urban area U_2, in country C_2 and in year T_2.

Yet, there are good reasons to believe that there is a significant potential for meaningful comparisons in the field of urban transportation research. First of all the advantages of international exchange of information are all too great to be ignored. Secondly, there are sub-fields of transportation where a significant effort has been made to assure comparability of theories and results. For example, in the field of traffic engineering the terms, definitions and basic classifications have already been made quite uniform and comparable. Finally, even in transportation planning some comparisons have been made in methodologically acceptable ways, either in the scale of the same country, e.g. [1, 2, 3, 4, 5] or internationally, e.g. [6].

Overall, however, in the field of urban transportation modeling and planning -- particularly in disaggregate analysis -- we are still talking different languages (of course, linguistic barrier are not meant here). When the definitions of terms, classifications, etc. (if they exist at all) differ from study to study, any evaluation of the results and modeling approaches becomes virtually impossible. We cannot reasonably judge which theory is "better" if the empirical evidence includes non-comparable elements in the first place.

Developing a well defined, uniform, precise terminology should be treated as a first prerequisite for the development of this field, as has been the case in other, better developed research fields.

2.2 Coordination of the research of basic subsystems and their interrelationships

There is an obvious interdependence between the stage of development of the field and the stage of understanding of the cause-effect interrelationships which exist in a given field. The question "why?" should not be asked before the questions "who?" and "under what circumstances?", are answered. After deciding about the analysis unit and its proper stratification, a set of basic studies about the human travel behavior can be undertaken. Any general theory should not be promoted before sufficient empirical material is gathered. If the findings from different studies consistently support a hypothesis, there is a good chance that the hypothesis is formulated properly (however, it still does not mean that this hypothesis is the final one).

A step-by-step systematic procedure should gradually investigate more and more elements of subsystems involved in the analyzed process and verify new hypotheses. Only after successful testing of a set of hypotheses can a more comprehensive theory be conceived and tested. When the nature of the basic relationships is known, a formal mathematical or statistical description of the process or behavior can be attempted. A mathematical formula -- if obtainable at all -- should flow from systematic, patiently conducted basic studies of all the sub-systems involved.

However, current research in urban transportation modeling often starts from the other end. A given form of relationship, which is believed to be adequate to describe a certain phenomenon or behavior, is somewhat arbitrarily "imposed" on the empirical data. Even if the problem is drastically misspecified, there still may be enough empirical "evidence" to support the postulated relationship: we can calibrate nearly any model.

When the basic investigation of all relevant elements of all the subsystems involved is neglected, it may become difficult to avoid some conceptual mistakes and misinterpretations of results. Therefore, before theorizing, for example, about how to describe the nature of human travel choices, it seems wise to perform some basic and systematic studies first. Otherwise, our theory may be valid only in our notebooks.

2.3 "Non-dogmatic" theories and approaches: potentials and dangers

There is a tremendous impact from pioneering works on the entire development of "new" research fields. Urban transportation modeling is certainly not an exception. Many assumptions made by early researchers are still taken for granted although it is clear that at the time they were made, the empirical evidence was very limited. The validity of some assumptions, a priori classifications, etc. was never really carefully tested. Subsequent research

works gradually improved details of some theories, but the same "conventional" way of thinking was often followed nevertheless.

It becomes clear today that many of the traditional assumptions and model descriptions are unsatisfactory, e.g. [7,8,9]. Yet, attempts to propose an alternative look at problems are often met with negation or at least skepticism. New approaches, even if potentially interesting, are often rejected by reviewers because "they do not solve everything yer" and "are too sketchy".

Accusations that a new approach is "too rough" and therefore does not deserve any attention, is not always fair. It is like disqualifying the achievement of the Wright brothers because their plane was not the Concorde. Without those first "awkward" planes, there would be no Concorde today. A too conservative, skeptical attitude - "but it will not fly, anyway" - can effectively discourage non-dogmatic research and jeopardize the development of the field.

2.4 "Constructive" versus "destructive" research works

It is often easier to put down a new theory rather than develop a better one. This is particularly true if the criticized theory is only a rough hypothesis which is not supported by sufficient empirical evidence. Sometimes a new idea -- although sketchy -- opens an interesting avenue for promising research; at other times, however, it may only be a "theoretical speculation" which may not agree with observations made in the real world or even with common sense.

How should researchers react to new theories? As mentioned before, a critique which is too strong can discourage (or even disqualify) potentially significant research. This would certainly be undesirable. However, there should always be room for a "constructive" critique which can help the original researcher to clarify and improve his initial idea.

The response to the critique can, basically, be twofold: a) to discuss the critique and implement all the suggestions which are reasonable; or b) to ignore it and continue the original course, and treat the entire critique as a "misunderstanding of the new theory" or even as a "personal attack" on the researcher.

This last problem can be both an important and sensitive one. In any competitive market a "better product" should gradually replace a "worse" one. If the direction of the research is generally evaluated as being useless or even misleading, should it be continued and supported? Should a governmental agency (and taxpayers) sponsor research which is conceptually and methodologically "wrong", when -- at the same time -- hundreds of potentially more significant and more solid research ideas will not be developed further because of limits in funds?

The answer is neither simple nor universal. Some authors seem to "learn" a lot from a critique, significantly improve their work, and treat their fellow-researchers as helpful, stimulating partners. This attitude is relatively easy to adopt when the critique results in only "cosmetic" changes and improvements. In some cases, however, a critique can postulate so many major changes that implementation can practically invalidate the entire theory.

In the latter case, acknowledging the critique may not be an easy decision, particularly if the decisive critique comes some time after the theory was

first proposed. The authors may treat the critic of their theory as a "spoiler", almost a "personal enemy".

Putting aside all emotional aspects of the problem -- which is never easy -- fair, constructive criticism should be an unseparable part of the "healthy" research practice. Both "developers" and "spoilers" are needed since both can significantly contribute to the development of the field.

2.5 When to accept a new theory?

In many research fields there are extremely rigorous criteria established for accepting a new concept, approach, theory etc. Multiple tests have to be performed independently at different laboratories to confirm a new idea. Only, after all tests consistently show its validity, do researchers cautiously announce a "discovery".

In some fields, the requirement for confirming the validity of research conclusions is not only desirable but often absolutely necessary. For example, the effectiveness of a new drug has to be confirmed by several laboratory tests if one wants to avoid tragedies such as with the drug Thalidomide. Any new theory about strength of materials should be carefully tested: human life could be at stake if the theory is not fully correct. Also, traffic engineering theories have too much to do with the safety of drivers and pedestrians to be accepted without satisfactory empirical proof.

The field of transportation planning differs from pharmacy, strength of materials or even traffic engineering. First of all, travel forecasts, like any forecasts, are never expected to be fully accurate. Secondly, any mistake -- even a very significant one -- is not critical, although it is clear that a large error in a travel forecast can have a much more serious consequence than an error made in the daily weather forecast. Finally, in the field of travel forecasting, it seems to be particularly difficult to properly describe complex interrelationships between dozens of relevant factors influencing human travel choices.

This makes transportation forecasting a quite unique research field: mistakes are not absolutely critical and often are not even verifiable. Different urban environments make it justifiable to consider adequate theories individually. A serious problem with quality and comparability of data can make it very difficult to blame any researcher for a "bad" theory (and to prove its shortcomings), even if the theory is really "bad".

It is not surprising, therefore, that in a field where room for different proposals, descriptions, theories, etc. is so broad, many quite different -- and often contradictory -- theories have been developed over the years. They were often borrowed from other research fields and accepted rather liberally. The lack of common language of terms, definitions, etc., the shortage of good data sets, and the very nature of the field have altogether significantly contributed to this liberal attitude.

Another factor which seems to have some influence on the rather liberal evaluation of the research works, is a psychological one. Even if the evaluated research is basically "incorrect", the reviever may be afraid that in a field so vague and "unpredictable" he/she should be "too liberal" rather than "too tough". After all, his colleagues evaluate him, too.

This situation leads quite often to some premature "discoveries", conclusions and generalizations. Some authors seem to perform the empirical part

of their research only to confirm their actual beliefs, while the nature of their research field often leaves enough room for convenient, favorable interpretations. Some others do not test their theories at all.

Some "bad" theories can, therefore, live quite long. Since the risk to "fight" them openly may often be too high, it is easier and safer to gradually ignore them. Eventually, they should be forgotten. However, this can be an all too costly process. Inexperienced newcomers to the field may become adherents of some "bad" theories, particularly if their original authors are lobbying heavily for their support.

Generally, a more strict attitude should be taken while evaluating and utilizing new theories. Of course, this does not mean that everyone should follow only one approach and one way of thinking. This is rather an appeal to avoid unnecessary mistakes by establishing more strict requirements for systematic, well-defined and coordinated research in this transportation sub-field.

Transportation modeling is a new field with many unanswered questions. A correst answer to one raises other questions. There should not be, therefore, any danger of a shortage of work for any researcher in this field.

3. DATA COLLECTION AND ANALYSIS: A METHODOLOGICAL AND ETHICAL PERSPECTIVE

3.1 Quality interdependence: data and theories

There is a strong interdependence between the quality of a theory and the adequacy and quality of supporting empirical material. First, "bad" data cannot support a "good" theory. The lack of adequate empirical evidence can laeve a theory unproven even if it is potentially attractive and seemingly correct. Second, a "bad" theory can adversely affect the quality of data.

For example, the survey team may not see any necessity to record variables which are not considered relevant to the research. Later, when the overall understanding of the problem is better, other variables may be found necessary, but they are no longer obtainable.

Data collection requires substantial knowledge, not only technically (proper survey method, sampling method etc.), but also conceptually and analytically: what information is needed and how it will be utilized. In some cases, clarity about future data utilization and a good overall understanding of the analytical issues involved can also improve the accuracy of data collected.

3.2 Problem with data comparability

Data collection for travel demand analysis and forecasts is, generally, a huge and costly effort. Home-interview type surveys require a lot of time, money and manpower. It is important, therefore, that this effort is properly deployed particularly if it is sponsored by a govenmental program, i.e. taxpayers' money.

Often, the data is gathered for one concrete research effort. Potentially however, the same data can be used a) for some inter-city comparative analysis, modeling efforts and transferability tests; b) for a study of temporal stability of travel behavior (if a second survey is planned in the same area).

3.3 Utilizing someone else's data

Is there a data owner? The original team may sometimes be unwilling to provide someone else with data which they may have a right to consider as their own. In the first place, the data may not be suitable for other analyses. Even if it is not the case, the original owners may want to prevent any potential misuse or misinterpretation of their data. Also, there is always a possiblity that the "other groups" can make better use of the data and "sell" it more effectively than the original team. Finally, the original team may feel uncomfortable about the possibility of verification of their results. Sometimes a comparison can reveal some differences in findings because: a) one of the teams made a mistake or/and b) both teams made some different manipulations with the data (e.g. elimination of the wrong records etc.). This can cause some undesirable confusion about the quality of work done by the first team.

Yet, the widespread use of data sets gathered some years back is a quite common practice in transportation modeling in several countries, particularly when the sets are owned by governmental agencies. The international exchange of data sets -- other than aggregate official statistics from the United Nations, World Bank, UITP, IRF, etc. -- is still very limited, although, for example, the author of this paper has the good fortune to be using a large disaggregate data set from Germany. Cases of such cooperation and mutual courtesy should be strongly encouraged and are always deeply appreciated. Maybe in the future we could even have an international data bank for disaggregate travel demand analysis?

3.4 Testing controversial findings

In some research fields there are formal requirements for an independent confirmation of research results, particularly if they are unexpected and controversial. In many fields, duplicated, independent analysis can often be made without any need of using the same laboratory or the same testing objects. For example, some biological experiments can easily be retested on another group of experimental animals in another laboratory. Of course, identical experimental conditions have to be assured. If the test results are divergent, another series of tests is performed independently, in order to find out which tests were correct.

In order to confirm (or disprove) a controversial finding in transportation analysis, one can also try to test it by using other data sets. This, however, would often amount to judging A by using the evidence from B. Even if findings are significantly divergent, the main reason can be the lack of data compatibility rather than some type of error.

It may be useful, therefore, to return to the data set used by the original team and retest the controversial findings. There are some indications that such a procedure is not often followed. Even an attempt to independently repeat a computer run which led to some "mysterious" findings can be regarded as showing a lack of confidence in the original team. In some cases, the original team may effectively prevent any retesting. This is unfortunate since -- as in other research fields -- standard checking practice could prevent: a) errors (which can happen anywhere); or b) more or less intentional misinterpretations of the empirical findings. Both impede the development of the field.

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Unfortunately, the problem with data comparability is more drastic than one would suspect. Costly data sets from different metropolitan areas (if available at all after years) are rarely comparable and often cannot be made comparable. Some modeling approaches do not recognize these differences directly. Thus, some statistics can be produced for comparison, even if sets are virtually non-comparable. Anyone who spent some time on detailed studies of individual trip records from different cities must have encountered the distressing fact that these are often not comparable and of poor quality.

In many cases even the basic principles of trip recording are different. The definition of a trip can vary from one study to another (walks included or not, problem with shortest trips, problem with a mixture of intra- and inter-city trips, etc.). Travel time values can be recorded as "true," perceived or network values. Some sets include both work and weekend days, while others have, say, only work day records, etc. Some sets contain only "cleaned" trip records, (i.e. those for which trip chaining begins and ends at home), while others -- because of the one day survey limit -- also retain trips which are not "balanced" (e.g., a record of a single trip per day).

There are also important differences in data sets due to the description of the real or potential traveler. Sometimes, this person cannot be directly identified if the record contains only general information about the household, instead of individual household members.

Another very common problem is "non-travelers" i.e. persons who did not travel during the survey day. Most of the "old" modeling approaches did not bother to identify these persons. More recent modeling approaches are interested in identifying "non-traverlers," in order, for instance, to find out whether their immobility was the result of their low travel demand or the unsatisfactory supply of transportation services. For the person-oriented behavioral modeling approaches, information solely about the total number of non-travelers is insufficient since they have to remain unidentified.

Is it easy to make data sets compatible? Sometimes - yes, but it may result in some metholological deficiences. For example, we can exclude "non-travelers" from newer data sets to make them compatible with the old ones. However, the methodological advantage of analyzing the records of non-traverers will be lost and some "better" modeling approaches will not be applicable for inter-city comparisons.

In many other cases, sets have such inflexible data records that to make them comparable becomes a practically impossible job. This happens often if some variables are already arbitrarily prestratified, e.g., age groups. If this prestratification is "unreasonable" and very different from others, we lose the potential to make a valid comparison of results. The missing original information from the survey is, usually, unobtainable after the survey is completed. The chance for interesting comparisons, tests etc. may be lost forever.

Often, data sets are used by researchers other than those involved in the original survey. However, neither the survey conditions nor assumptions made by the survey team (e.g. about the sampling method) may be known or available. In these cases the danger of "comparing applies with oranges" is particularly high.

4. RESULTS PRESENTATION AND INTERPRETATION: A METHODOLOGICAL AND ETHICAL PERSPECTIVE

4.1 Quality interdependence: theory - data - results

It is not uncommon to find that "excellent" empirical results are accompanied by theory which is very weak (or even clearly incorrect), and/or data of very poor quality. These results have to be read with caution. If the modeling results based on two totally non-comparable data sets are very close or nearly identical, the researcher does not have much reason for satisfaction. If his/her theory is right, the significant differences in, say, trip recording, should result in different rather than similar findings. "Strikingly" consistent results based on noncomparable data sets can be a result of: a) coincidence, b) error, c) non-intentional or intentional misinterpretation. Non-intentional misinterpretation can happen anywhere -- it is everyone's right to be wrong -- but intentional misinterpretations and data manipulations should be treated as an unfortunate malpractice which obstructs the development of the field.

4.2 Selective use of empirical evidence

Let us suppose that part A of Fig. 1 represents some empirical findings from 25 different cities.

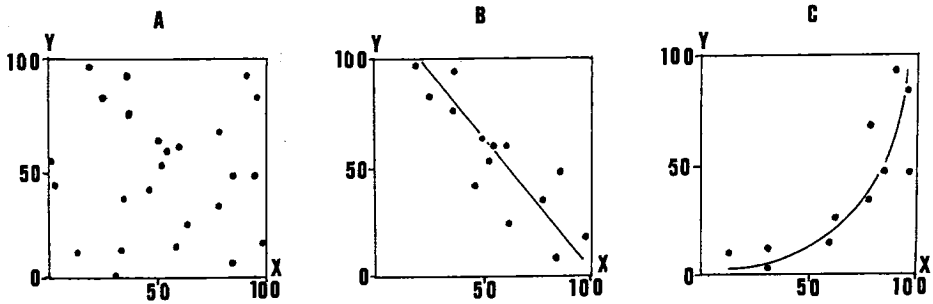

Fig. 1. Different "interpretations" of empirical findings

We might have some expectation about the form of the relationship which, say, should be linear and inversely proportional. A closer look at part B of Fig. 1 could "convince" us that the relationship basically holds, with the exception of some cities which actually are so untypical that they should be excluded as "outliers". After this operation (part B) the relationship looks very solid and the regression statistics should be quite impressive.

Someone else, however, who believes that Y should increase, say, proportionally to the third power of X, can also find enough evidence in empirical findings (part C of Fig. 1). As before, some points will "have to" be excluded and justification to do that will not be very difficult ("untypical cities," for example). Thus, the contrary theory has been "proven".

One may wonder what the "true" relationship is in this case and what the dots in Fig. 1 really refer to. The answer is probably not unexpected. They represent 50 two-digit random numbers: first 25 for X and next 25 for Y.

The "relationship" is meaningless.

This not quite serious and, obviously, exaggerated example illustrates -- at least to some extent -- a more serious problem. That is, first, it is relatively easy to find "relationships" even where there is no basis for their existence. Secondly, a selective use of empirical findings -- to put it mildly -- can "help" us to "prove" our point. If Fig. 1A represented a real set of empirical findings, the transformations 1B and 1C would not even falsify any individual observation - it would only eliminate the "inconvenient" part of the empirical evidence.

Presentation of portions of empirical evidence -- the "good" (or "better") parts -- still occurs in the practice of transportation research. Sometimes extreme empirical points -- potential spoilers of our correlation coefficients or coefficients of variance -- are eliminated as outliers. Although, clearly, there may be cases of evident errors in the data records which have to be excluded from the set, the "cleaning" of data can easily go beyond necessary corrections into intentional manipulation of data. The judgement about outliers should always be based on a valid conceptual argument.

4.2 The "art" of presenting and interpreting results

Everybody is familiar with the methods which can, for example, show the economic decline of a company less dramatically than in reality. There are multiple "tricks" that can be used in presenting results. Using ratios instead of totals often "helps". The cumulative frequency distributions will always be more similar to each other than non-cumulative ones, etc. These examples can be multiplied.

The field of urban transportation modeling is not a strict science, as is, for example, chemistry. This leaves a lot of room for multiple ways of presenting and interpreting empirical findings.

In many cases the methodological errors can make the "really" existing regularities invisible at the "wrong" level of data aggregation. Sometimes, on the contrary, artificial or trivial regularities can be taken as encouraging empirical evidence. For example, the finding that a larger family makes more trips than a smaller one is just trivial. In other cases, a lack of relevance is interpreted as regularity. For example, the finding that persons with blue, brown, green, gray, etc. eyes spend a similar number of X hours a day watching TV does not reveal any regularity. It only shows that color of eyes -- similar to hundreds of other potential variables -- has nothing to do with the variable: time spent watching TV. If the sample is large, any irrelevant stratification should show similar means X_i, which can be taken as a "consistent, regular result."

Interpretations similar to the above examples happen from time to time in the field of transportation modeling, and probably in other transportation and non-transportation research fields, as well. The joint effort made by the fellow researchers all over the world can and should significantly improve the quality of transportation research: its theories, data, and findings. We all will gain from that.

5. SUMMARY AND CONCLUSIONS

A) This paper deals with some methodological and ethical aspects of transportation research, mainly with references to urban transportation model-

ing and planning. Methodological and ethical issues are often strongly interrelated and have a significant influence on both the quality and progress of research.

B) There is an urgent need for internationally coordinated transportation research. This could bring about a more efficient deployment of funds, time and human resources for both international and national projects. More solid and more carefully verified reports would provide a better base for any new research task and would improve the overall quality of research.

C) There is a need for standardization of basic terms, definitions and classifications to assure comparability of results. This should be seen as the main prerequisite for the successful exchange of international research in this field.

D) Transportation modeling and planning should routinely adapt high scientific standards, such as those in some better developed and "more demanding" research fields. The very nature of this field, and its present state, create a situation where there are possibilities for misinterpretations of empirical finding and the promotion of some ill-focused theories.

E) Transportation modeling and forecasting is a relatively new, still not-too-well developed and not-too-strict sub-field of transportation research. The relative flexibility of this field creates opportunities for some ethical looseness to exist. Nevertheless, by adhering to some basic principles of research (by strictly handling empirical results: whether good or bad, by verifying results, avoiding premature conclusions, etc.) we can look forward to more rapid progress in the field, and a better quality of research work.

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REFERENCES

1. Böhme, U. (1970) Grundlagen zur Berechnung des städtischen Personenverkehrs, Ph.D. dissertation, Technical University of Dresden.

2. Kutter, E. (1973) A Model for Individual Travel Behavior, Urban Studies 10, No. 2.

3. Brög, W. (1979) Mobility and Lifestyle-Sociological Aspects. Paper for the Eighth International Symposium on Theory and Proctice in Transport Economics, Istanbul.

4. Goodwin, P. (1975) Variation in Travel Between Individuals Living in Areas of Different Population Density, Greater London Council unpublished report.

5. Supernak, J. (1981) Travel Time Budget: A Critique. Paper for the International Conference "Travel Demand Analysis: Activity-Based and Other New Approaches," Oxford University.

6. Bayliss, D. (1981) One Billion New City Dwellers - How Will They Travel? Transportation No. 10.

7. Stopher, P. R., Meyburg, A. H. and Brög, W. (1981) Travel-Behavior Research: A Perspective, in Stopher, P. R., Meyburg, A. H. Brög, W. (eds.) New Horizons in Travel-Behavior Research, Lexington Books.

8. Herz, R. (1982) The Influence of Environmental Factors on Daily Behavior, Environment and Planning A, Volume 14.

9. Supernak, J. (1982) Transportation Modeling: Lessons from the Past and Tasks for the Future. Paper for the Tenth Summer Annual Meeting of PTRC, University of Warwick.