

CONTRIBUTION TO EVALUATION OF INTERMEDIATE VARIABLES; BACKGROUND PAPER

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SUMMARY

An important issue for evaluation is the discussion about the methodology of traffic safety research.

There are two opposite approaches to traffic safety research, one starting from accident analysis, the other from the traffic process. In this background paper the stage is set for a discussion about the contribution of intermediate variables to evaluation, by giving a plea for the second approach.

The main argument regards the lack of theory in traffic safety research. There are a lot of notions about the causes of accidents but few of these notions are tested by means of scientific methods. It is argued that if the purpose of evaluation is primarily to learn from our activities in the past, then it is not enough to state results by means of the outcomes with regard to accidents, but also to investigate how these results are accomplished.

If one thinks of intermediate variables merely as surrogates for accidents numbers, then one ignores their most valuable contribution to traffic safety research.

There is a general feeling that we have to enlarge our understanding of traffic safety. It is argued, that the only way to do this is to start from systematic observation of the traffic system in order to detect when things go wrong and why this is the case. Validation of conflict techniques should be directed more to the relevance of the operational definition with regard to this purpose than to the prediction of accidents. The "predictive validity" can only be increased if one improves the "construct validity".

The report of the OECD high level group on integrated safety measures is mentioned together with the Malmö experiment of the ICTCT as valuable steps in this new direction.

CONTRIBUTION DES VARIABLES INTERMÉDIAIRES A L'EVALUATION; INTRODUCTION

RÉSUMÉ

Discuter la méthodologie de recherche en sécurité routière constitue un point important pour l'évaluation.

Il existe deux approches antagonistes de la recherche en sécurité, l'une partant de l'analyse d'accidents, l'autre de l'observation du trafic lui-même. Dans cet article d'introduction, le cadre d'une discussion sur la contribution des variables intermédiaires à l'évaluation est mis en place avec un plaidoyer pour la seconde approche.

L'argument principal concerne le manque d'une théorie dans la recherche en sécurité routière. Il existe un bon nombre d'hypothèses sur les causes d'accidents, mais bien peu d'entre elles ont été testées avec des méthodes scientifiques. On remarque que si le but de l'évaluation est principalement d'apprendre à partir d'actions passées, on ne peut se satisfaire de simples résultats concernant les effets sur les accidents de ces dernières, mais on doit également analyser comment ces résultats ont été obtenus.

Si l'on considère les variables intermédiaires uniquement comme des substituts pour des nombres d'accidents, on ignore alors l'essentiel de leur contribution à la recherche en sécurité routière.

Le développement de nos connaissances en sécurité routière est un besoin généralement admis. On soutient dans cet article, que l'on ne pourra répondre à ce besoin qu'en partant d'une observation systématique du système de circulation, afin de détecter quand les choses se gâtent et pourquoi. A cet effet, la validité des techniques de conflits de trafic devrait se mesurer en termes d'adéquation de la définition opérationnelle, plutôt que d'aptitude à prédire les accidents. La "validité prédictive" ne peut augmenter que si l'on améliore la "validité par construction".

Le rapport du groupe de haut niveau de l'OCDE sur les programmes intégrés de sécurité, ainsi que l'expérience de Malmö organisée par ICTCT, constituent des étapes importantes dans cette nouvelle direction.

## INTRODUCTION

This session is primarily concerned with the methodological problems of traffic safety research

Some of these problems have been stated many times but don't seem to loose attraction. In the Amsterdam meeting on "Short term and area wide evaluation of safety measures" this issue was noticed to be of great concern to researchers, and a continuation was suggested.

The main issues of that meeting are still the main issues of today. One of these issues regards a difference in opinion about traffic safety.

The first point of view can be phrased as follows: "Traffic safety analysis is accident analysis and the rest is at the most a surrogate for accident analysis but for the major part a nuisance and a waste of time and money".

The opposite point of view is:

"Traffic safety analysis is the analysis of the traffic proces leading to accidents; accident analysis is incomplete and non-scientific because it neglects to investigate how accidents occur".

This controversy generates a number of other controversies. One of these regards the use of intermediate variables. This background paper will try to set the stage for a discussion about the use of these variables. It is set in a somewhat provocative way pleading for the second approach. It opens with a description of the aspects of the work traffic safety specialists are confronted with. It claims that if we accept the fact that these aspects are all necessary parts of the analysis, then the use of intermediate measures results in a more comprehensive approach to traffic safety research.

In order to find a cure for the problems of traffic safety, we first have to detect and locate the various problem areas. Futhermore we have to analyse the problems in order to find out what causes the occurrence of accidents and also what kind of solutions can be suggested to improve an unsafe situation. Finally we have to evaluate whether the cure we suggested did or did not solve the safety problem.

It can be stated that until now the main interest of safety workers has been directed at the detection of the problem. The diagnosis of the prob-

lem and the arguments that led to the prescription of the cure are in the majority of the cases kept in the black box of the safety worker. Recently, there is an increasing interest in the evaluation of safety measures. However, most of the interest in evaluation is primarily concerned with a check of the outcome of the cure instead of a reflection on the process of curing. To state it sharply: the safety worker is regarded to be more a medicineman than a scientist. The major part of the traffic safety researchers are indeed working more from intuition than from theory. The implicate notions, their work is based on, are lightly taken for granted. We can even say that, in the strict sense, there is no theory of traffic safety at all.

But if evaluation means in essence to learn from past experience in order to see what is valuable and what is not, then one may wonder what we can learn from the application of implicate notions unless we try to make them apparent. What is there to learn from past experience when we do not make our theories explicite in order to test them, but only try to rationalise our actions afterwards?

THE THEORY OF TRAFFIC SAFETY

If we want to formulate a traffic safety theory the first question must be: what is the object of our study? The answer that has been given for a long time seems to be (explicitely or implicitely) the accident. This erroneous answer has caused a lot of confusion, but also a lot of inefficiency. The object of traffic safety theory is not the accident but it is the critical event in traffic.

The misconception is also leading to a number of discussions that are relevant for the theme of this session. The use of the term "surrogate measures" for intermediate variables shows the disapproval of this source of information that is regarded to be of some value only if accident information is lacking. The assumption that safety and accidents are identical has furthermore led to the belief that indepth-accident-studies are the key to a better understanding of traffic safety. However, in spite of the enormous amount of money spent on these studies, the results are less promising than was expected and this will continue to be true unless a more theoretical approach will be accepted in this field.

Of course it is true that accidents are the outcome of unsafe traffic situations and that we can measure unsafety in the end only by the accidents that happen. Without accidents there is no proof of unsafety.

However, there is a difference between stating a fact and explaining its appearance. As such it is not surprising that, in a period of a turbulent development of traffic, car-park, roads and number of road-users, the detection of problem areas by means of accidents is of major importance. The last few years however, we see a diminishing growth and a more stable state in traffic which appears to result in more time for reflection and more interest in theoretical aspects than there was before.

As said earlier, the object of the traffic safety study is not the accident but the risk we all run if we take part in traffic. How do accidents happen? What situations in traffic have a high accident potential? If we study accidents we try to trace backwards from the outcome of a situation the causes that led to that outcome.

But all the relevant information on the 5 or 10 seconds just before the accident is almost completely lost and only a small, non-representative part of it will be found in the dossiers that are constructed afterwards. If we seriously want to improve our safety measures, we must improve our understanding of how accidents happen.

There are a lot of notions about the human factor in safety. These notions are often moral judgements instead of scientific theories. The fact that many road-users drive their car with 100 km/h in fog-conditions is classified as "unresponsible behaviour". But more important is the question why so many of us do these crazy things and in what conditions. The theory of learning e.g. tells us that feed-forward is better than feed-back in this kind of situation. The pseudo-scientific notion of "risk homeostasis" is an other example.

The dutch-calvinistic preacher of this belief is telling us that the danger is not outside in the surrounding world but inside the road-user himself. At first only in his mind, but now even in his body. The road-user is the great sinner who is responsible for all misery. These moral and religious prejudices can only be surmounted by careful systematic observation in order to test scientific theories. From a decision theoretic point of view it is clear that for the individual road-user "minimal loss" is not the same as maximum security. This broader view shows that the phenomenon can be sufficiently explained with underestimation of risk and risk-acceptance and that there is no need for a concept of "constant risk" related to the pseudo-scientific freudian notion of pervert death-wish.

There are a number of scientific theories that can be applied to improve our understanding of the safety problems in traffic and to help us in finding solutions.

## THE PURPOSE OF EVALUATION

The purpose of evaluation is primarily to learn from our activities in the past in order to improve our future work. Evaluation seems to become more and more important. One reason is that we all want to prove that our work is still effective while others think it is not. A second reason may be that we, ourselves become more uncertain about the effectiveness of our work and want to improve it. Furthermore, the solution of recent problems, especially those in residential areas, ask for a much more subtle treatment.

Especially when less money is available it is important to show the effectiveness of traffic safety work, in research as well as with regard to applications.

As said before, the scientific way of learning is to test theories and not merely to state the outcome of measures. The first step however to construct a traffic safety theory is to start with systematic observation of the traffic safety object: the critical event in traffic. In order to find out why things go wrong in traffic, we have to make a distinction between situations in which road users fail from those in which they succeed to prevent accidents. There are various theories formulated contributing to the explanation of these facts, but they are seldom checked in practice. Mean while they are used as a basis for taking safety measures. In most of the cases there is only an evaluation of the outcome of the measures instead of a confirmation of the theories that were at the basis of the action. However, the number of accidents is often small. Also the implementation of safety measures seldom shows more than 30% reduction in accidents. Statistical testing therefore fails to show effectiveness in these cases. Mainly for this reason, people accept surrogate measures, such as the number of conflicts, as a replacement of the number of accidents. One has to show at least some effect!

This negative attitude towards the conflict-method has been blocking progress for a number of years. The only attention that has been given to the technique consists of the replacement of accidents by conflicts.

Although it is of course very legitimate and very important to ask for the reliability and validity of this technique before it can be used as a surrogate, the question about validity again is stated in a negative way: What is meant by validity is only "predictive validity". The question



about "construct validity" is hardly ever mentioned. It seems that there is no scientific interest in how we have to measure conflicts, or how to define unsafe situations but only in the number of counts that resulting from such a technique. Still, if we want to improve the predictive validity of conflict techniques, we have to improve the way of measuring conflicts.

It seems almost indecent to use conflicts, and people using them are always forced to defend themselves: show us that your technique works, show that the predictive validity is high enough and we will accept your technique (as a surrogate).

This criticism is typical for conflict-techniques and other behavioral observation techniques. However, in many cases where people use speed-measurements in almost the same way as conflicts are used, this seems to be accepted easily. The reason may be that speed is a simple and more direct factor in traffic and more easy to measure, but from a theoretical point of view the problem is the same: how does this factor relate to safety? What really is important is to know which combination of circumstances do make a situation dangerous. In some situations a speed of 20 km/h can be fatal, in others it is hardly dangerous at all. Only careful systematic observation will in the end teach us what cues are relevant for the discrimination of dangerous situations from not safe ones. The same reason applies to the effect of safety measures. Safety measures do not have their effect directly on accidents but on traffic and only by implication on the number of accidents to be expected.

Evaluation therefore also has two stages: first it has to be shown that the safety measures do have a positive effect on traffic, second that this effect indeed results in less accidents. We call these stages process-evaluation and product-evaluation.

THE USE OF INTERMEDIATE VARIABLES

As said before, most attention to intermediate variables results from the fact that accident numbers are in many cases too small for valid prediction of safety problems or effectiveness of safety measures. This approach leads to the use of intermediate variables as surrogate measures of safety. However, more important is their use for safety diagnosis.

Traffic safety work needs a theory about danger in traffic. All theory starts from systematic observation of the object of study, here the critical traffic event. The object of conflict studies therefore need not be to count critical events, but to study these events. This fact has many implications:

- It is not that important to have a precise definition of a conflict, a rough demarcation rule to select relevant situations is sufficient.
- It is much more important to define the seriousness of conflicts, because this is the link to danger
- It is also important to distinguish between serious types of conflicts and less serious ones.
- It is crucial to detect the relevant cues that have to be taken into account in order to define seriousness for various situations.
- It is also crucial to distinguish between those factors that are relevant with regard to the probability of an accident resulting from a conflict and those factors that are relevant with regard to the damage that results from an accident if one occurs.

As far as these aspects are concerned, conflict-analysis techniques are just in "statu nascendi" and much work has to be done to make full use of them.

The conflict method should more be used as a method to look at safety problems in traffic than merely as an indicator of unsafety. Conflicts therefore have to be specified for specific problems. Their use for the diagnosis of pedestrian problems in residential areas is completely different from their use in the analysis of weaving problems on motorways. A number of fruitless discussions about whether TTC-measures are superior to PET-measures stem from the idea that unity in concept also implies unity in measure. The conflict method, or better, the systematic observation of critical traffic events, is one of the most important tools we

have to detect and understand the safety problems in traffic. Safety engineers can improve the results of their safety analysis at intersections if they not only look at the lay-out of an intersection but also pay attention to the relation between the (provoked) traffic behaviour and the lay-out of the intersection.

It is not wrong to work from hypotheses that specify solutions for the dangerousness of lay-outs but the only way to improve these hypotheses is to learn from past experience by testing them. In this sense it is better not to speak of evaluation of safety measures but of confirmaton of safety theories.

The theoretical basis for a measure may be sound but the measure still may not work. It is necessary to have this understanding.

All that has been said about intermediate measures is of course not restricted to the conflict method but also applicable to the use of behavioural methods in general.

The conceptual framework as formulated in the OECD-report of the high-level group on "integrated road safety programmes", gives a comprehensive and general description of these ideas.

The work that has been done by the ICTCT, especially with regard to the Malmö-study, can be regarded as a first step towards a sound basis for systematic observation of critical events in traffic. The conflict situations that we all learn from when we take part in traffic as a road-user, are also the only sound basis for a more reflective and theoretical approach to traffic safety and the understanding of the risk in traffic. Because in traffic the degrees of freedom for the individual road-users are extremely large, traffic safety problems have to be solved by those road-users themselves, while safety workers can only improve the conditions. This is the main reason for the importance of the study of traffic behaviour.

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