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TRAFFIC SAFETY IN DEVELOPING COUNTRIES: INTERMEDIATE VARIABLES IN ACTION PLANNING AND EVALUATION

Introduction

Traffic safety researchers usually gain experience by working on problems arising in their own country or, occasionally, on others very similar to theirs in terms of way of life, economic conditions, and motorization levels; Western European countries, for instance, can be considered as relatively similar, although there are differences in behavioural and accident patterns: research methods at least apply, if not always evaluation results.

Over the last ten years, traffic safety problems have become acute in other countries belonging to the "developing world", where experience in dealing with these problems is scarce and basic information often missing. Researchers from industrialized countries, where safety policies have been carried out and (optimistically speaking) followed up for several decades are called upon to help establish safety diagnoses and design adequate action programs. This requires serious adaptation of working hypotheses and methods.

The need for adaptation can be summarized in one global question: some knowledge of the processes determining behavioural patterns, generating accident situations, or leading to success or failure of safety measures, has been acquired in countries enjoying more or less the same social and economic conditions; how much of this knowledge can apply to countries where the present geographical, technical, and human context is radically different ? In order to work usefully in developing countries, traffic safety researchers need to analyze the local variables that may influence traffic processes and thus have a bearing on accidents and on the effects of countermeasures.

The first step of adaptation is to identify the relevant variables. For this, a logical framework is necessary. The approach sketched here is based both on recent developments in traffic safety research in Western countries (Muhlrad, 1989) and on field work in developing countries (Muhlrad, 1987).

Recent trends in traffic safety research in industrialized countries

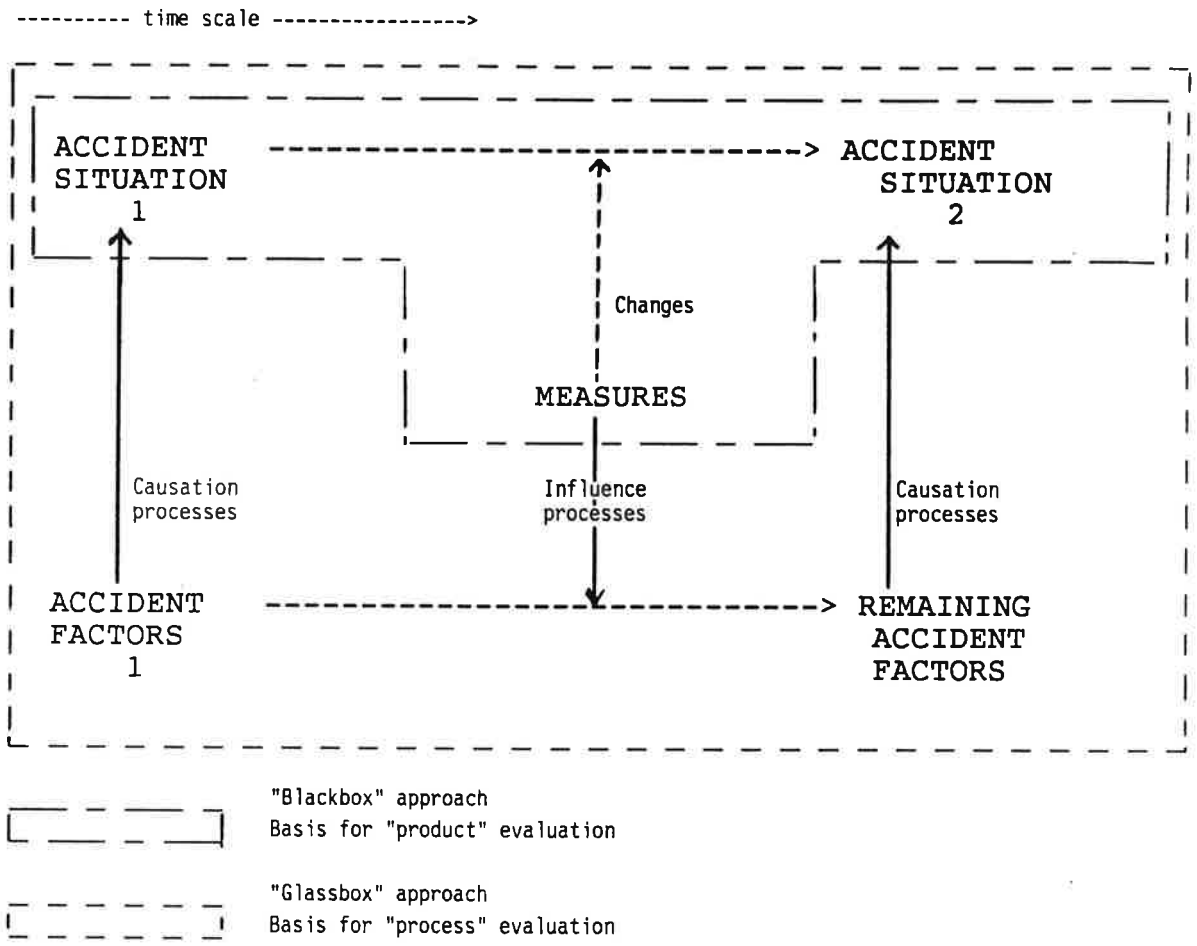
Traffic safety work in industrialized countries, particularly in Western Europe, has taken a new turn in the beginning of the 80's. Typically, the early approaches involved analyzing the accident situation in terms of prominent types of accidents susceptible to particular countermeasures (road markings, signals, blackspot treatment, traffic laws, media campaigns, child education, etc.); countermeasures were tested a-priori on sample of sites or population, then deemed generalizable to all similar situations; evaluation was of the "product" or final outcome of countermeasures, measured in terms of the number of accidents or victims avoided (Fig.1). There were only few attempts at making explicit any of the processes behind accident causation or accident prevention techniques, and these attempts remained very much at the research level. This early way of tackling the safety problems has been called the "blackbox approach" (Muhlrad, 1989).

At the beginning of the 80's, the "simple" countermeasures (at least the most obvious ones and the easiest ones to imagine and to implement) had been more or less applied in industrialized countries, and new forms of action had to be found. This implied better understanding of the processes generating unsafety; new forms of accident prevention strategies started being designed in relation to specific processes (local safety measures, safety campaigns, measures for two-wheelers, etc.); on the basis of this explicit relationship, "process evaluation" was carried out, to check the way measures worked (Wegman, 1982, Biecheler et al, 1985-86). Although it involves a different way of thinking safety analysis and accident prevention, this approach is in fact complementary to the earlier one and has been recently termed the "glassbox" (Fig.1).

In short, opening the blackbox (or adopting the "glassbox" approach) means investigating both the causation processes and the influence processes underlying accident prevention techniques.

From a safety action viewpoint, accidents are complex phenomenon that can neither be defined only by their outcome, nor summarized by simple statistical classifications; they need, for practical use, to be broken into simpler elements. By reconstructing accident generation processes, it is possible to identify causal factors, using an operational definition: a factor is an element intervening in a given process in such a way that if it had not been there, the collision would not have occurred or its consequences would have been less serious. The factors involved in a particular accident situation (or group of accidents with some common characteristics) usually constitute a sub-set of the traffic system including elements of infrastructure, environment, traffic, individual road-users and vehicles. Once the accident situation thus broken into a group of factors, it becomes easier to select some of them as intermediate variables on which to act in order to prevent accidents from happening (again) (Muhlrad, 1987).

FIGURE 1: "Blackbox" and "glassbox" approaches to traffic safety



Acting on a causation factor or on a group of factors intervening together to generate an unsafety situation means initiating an influence process that will either eliminate these factors or neutralize their unwanted effects. Designing safety strategies thus means imagining an influence process on the basis of sufficient knowledge of the psychological or physical origins of causation factors and of the part they play in the traffic system. Evaluating such strategies implies first of all that the validity of the influence processes initiated is checked (the measures applied should work according to the process intended, meaning that the factors chosen as intermediate variables should actually be eliminated or neutralized). Then product evaluation will show if the final aim is reached (reducing a particular group of accidents) and thus confirm the choice of intermediate variables.

In complex accident situations, opening the blackbox is thus necessary both to design suitable safety strategies and to evaluate their effects after application.

Developing countries from a traffic safety viewpoint

Countries of the world are officially classified on an economic basis, according to their GNP per capita (Fig. 2); under a certain threshold, they are considered as "developing".

Such definition has obviously no direct meaning to traffic safety researchers that need to adapt methods and results to traffic systems different from those they are used to. To this purpose, "developing" countries are better described through a set of criteria that segregates them from industrialized ones from both a mobility and a decision-making points of view. Such description may lead to a classification that does not entirely coincide with official ones, but it is more relevant to methodology or technology transfer. In this paper, a developing country will thus be characterized as follows:

a) Mobility conditions:
- motorization has grown suddenly and very fast;
- infrastructure and education structures have not followed this sudden growth;
- new mobility conditions are generating new ways of living, working and moving, which coexist with the old ways;
- individual and social values, as determinants of traffic behaviour, are related to each country's traditions, and may not have evolved significantly with the new ways of living.

b) Decision-making conditions:
- awareness of an accident problem is growing;
- most bases for decision-making are missing: little quality data, little knowledge about accident characteristics and causal processes; action is often decided on subjective bases instead;
- there is little "know-how" available to traffic safety professionals, and a lack of qualified manpower;
- resources available for safety action are scarce and there are even less opportunities for evaluation.

It has long been assumed that developing countries were following a pattern comparable to what was experienced at earlier stages of development in the Western world, and that accident rates would therefore decline in due time over there too. The description above indicates that reality is different: basically, changes in motorization have occurred on a much shorter time-scale than improvements of infrastructures (both social and physical) and adaptation of behaviour. This makes corrective safety action more necessary and more difficult than it was when industrialized countries were motorizing, while present economic growth does not allow for large investments in this field.

Because of the combination in developing countries of a quick increase of road accidents and a lack of adequate resources for action, there is indeed a case for traffic safety researchers to help gather appropriate knowledge and assess practical know-how in order to save the time and efforts needed to initiate sound safety policies. So, how do we identify useful knowledge and what have we got to offer developing countries

FIGURE 2: A classification of countries based on GNP per capita (OECD and World Bank, 1986)

Class of country	EUROPE	MIDDLE EAST	AMERICA	E.ASIA + AUSTRAL.	AFRICA
Very poor			Guyana Haiti	Kampuchea Banglad. Nepal Bhoutan Laos Vietnam Burma China India Afghanis. Maldives Pakistan Sri Lanka	Ethiopia Tchad Malawi Zaire Guinée B. Burkina F. Ouganda Tanzania Mali Zambia Gambia Madagascar Guinée Burundi Guinée Eq. Rwanda Somalia Togo Mozambique Sierra Le. Niger Kenya Soudan Benin Nigeria Comores Centrafri. Lesotho
Relatively poor	Albania Yougosla.	Yemen (S) Yemen (N) Lebanon Turkey Jordan Syria	Bolivia Honduras Rep. Dom. Salvador Nicaragua Jamaica Guatemala St Vince. Paraguay Columbia Cuba Ecuador Peru Belize Chile Dominique Grenada Ste Lucia Costa Ri. Mexico Brazil Uruguay	Indonesia Philippi. Papua NG Thailand Mongolia Korea (N) Malaysia	Ghana Mauritania Liberia Senegal Capo Verde Swaziland Zimbabwe Morocco Egypt Cote d'Iv. Cameroon Botswana Angola Congo Tunisia Djibouti Mauritius Namibia South Afr.
Relatively rich	Poland Hungary Portugal Cyprus Rumania Greece Bulgaria USSR Spain Tchecoslo. Andorra Ireland E.Germany	Iraq Iran Israel Oman Saudi Ar.	Panama Argentina Suriname Antigua Venezuela Puerto R. Barbados Trinidad Bahamas	Korea (S) Taiwan Hong Kong Singapore New Zeal.	Algeria Gabon Libya
Very rich	Italy St Marin U.K. Netherl. Belgium Austria Finland France Monaco Luxemburg Iceland W.Germany Sweden Denmark Norway Switzer. Liechte.	Bahrein Koweit Qatar Un.Ar.Em.	Canada Bermuda USA	Australia Brunei Japan	

Blackbox and glassbox approaches in developing countries

When initiating traffic safety policies in developing countries, the first idea that usually comes to the mind of decision-makers or donor agencies is that we know enough solutions that have worked in industrialized countries to start applying them elsewhere, provided the apparent problems (in terms of prominent accident situations) are the same. This is the blackbox approach to technology transfer (Fig.3).

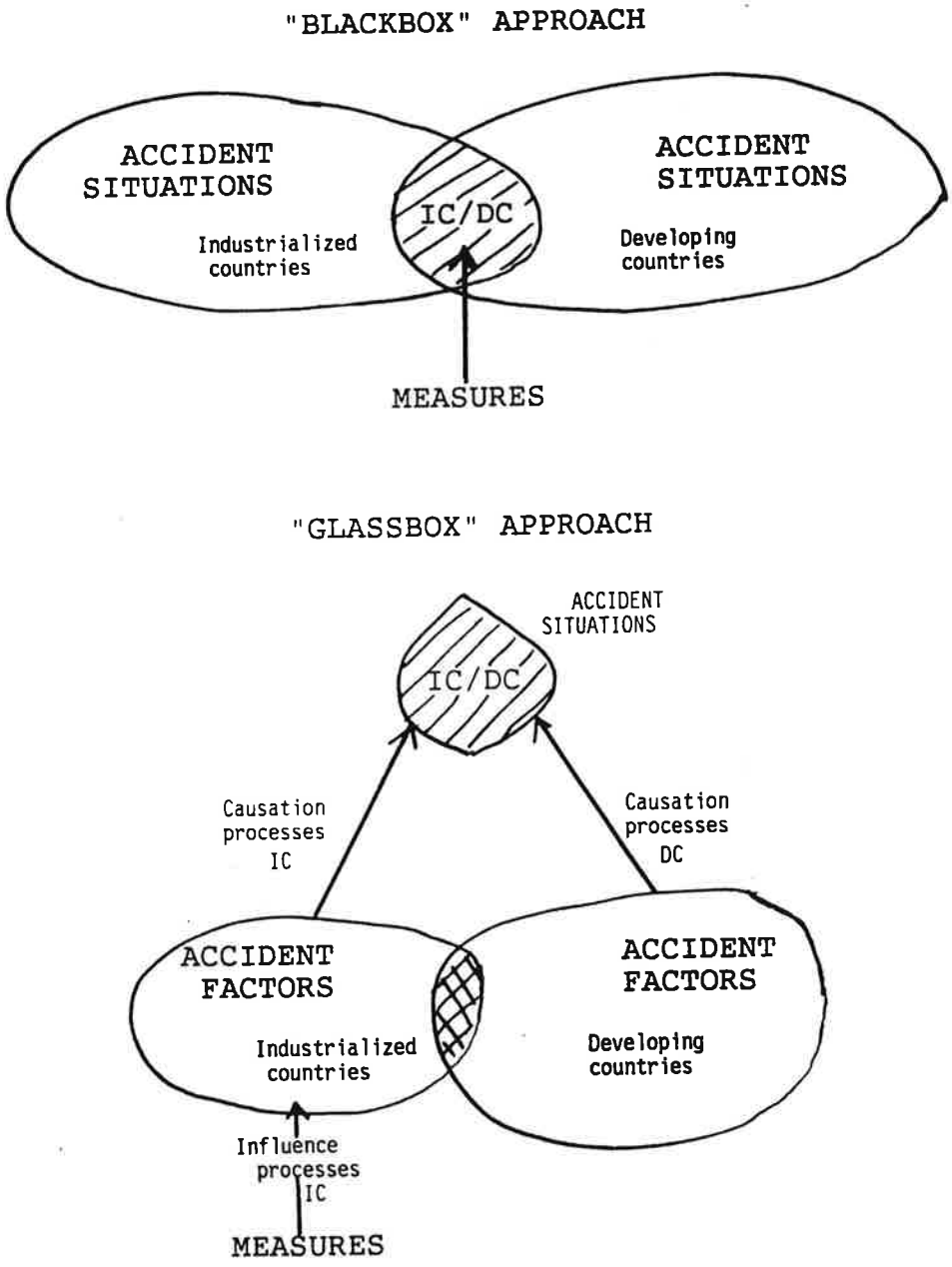
However, if we try to open the blackbox, we start thinking along new lines. Because the mobility conditions and the social background are so different in developing countries, there are no reasons to believe that roughly similar accident situations will be produced by the same processes. Consequently, the set of factors involved should also be different from those identified in industrialized countries. Well-proven countermeasures may thus be based on the wrong hypotheses for developing countries, due to a wrong choice of intermediate variables (Fig.3).

Take, for instance, pedestrian accidents occurring in urban areas outside pedestrian crossings. In any European countries, the factors involved in such a situation and which may be influenced by remedial measures are likely to be in the following list:
- neglect of zebra crossing by the pedestrian;
- careless behaviour when crossing or inability to appreciate vehicle speeds or gaps in traffic (this is most often related to a child or an elderly pedestrian);
- short sight distance at the crossing spot (often due to parked cars);
- excess speed of drivers;
- at night, insufficient public lighting.

Pedestrian accidents in urban areas in developing countries will mostly occur outside zebra crossings, not because of pedestrian carelessness, but because there are no (or very few) zebra crossings. Careless crossing or misperception of vehicle movements are not mainly the fact of children or the elderly as even adult pedestrians have often too little experience of traffic to cope with it. Short sight-distance is a frequent factor in many third-world cities, but it is usually due to commercial activities at the roadside rather than to parked cars. Insufficient public lighting (even the absence of it) is a generalized feature, just as lack of crossing facilities. More typically, lack of attention of the drivers to pedestrian movements and inadequacy of drivers' reactions when an emergency situation arises are frequent factors, while the existence in some cities of wide arterials where drivers are invited to drive fast and the number of lanes to cross (without a central reservation) is high also plays an important part in pedestrian accidents.

It is obvious in this example that blindly applying countermeasures experienced in Europe (make zebra crossings more attractive to pedestrians, teach children, eliminate kerb-parking in areas with heavy pedestrian frequentation, check speeds through adequate devices, introduce special lighting at crossing zones, etc.) will not help enormously in a typical developing city.

FIGURE 3: "Blackbox" and "glassbox" approaches to technology transfer



Similarly, we can make the assumption that influence processes will be different in industrialized and in developing countries because the determinants of behaviour, whether related to interactions of the road-users with their environment or to personal or social values, cannot be the same. So, even if a known countermeasure aimed at the right factor is applied, it may not be able to influence it in the intended way.

From this discussion, it can be seen that it will be quite difficult to build up a "tool-box" for safety professionals in developing countries. The glassbox approach shows that countermeasures (or sets of them) which have been experimented to cope with a specific accident situation (or "target-group" for action) will be directly applicable only to similar accident situations, involving some similar accident factors (those chosen as intermediate variables), responding to similar influence processes. It means that the amount of knowledge necessary to assess applicability of a given measure includes at least a complete diagnosis of the new accident situation and a thorough description of how countermeasures work (intermediate variables concerned and influence processes).

Countermeasures (or sets of them) must be evaluated in such a way that transferability of results can be assessed; in this view, "product" evaluation in itself is valueless without the complement of "process" evaluation ! Apart from recent studies on the effect of local safety measures (Wegman, 1982, and Biecheler, 1985), most of the evaluations carried out in industrialized countries have been of the product, which makes them somewhat useless for developing countries' purposes. In order to help build up professional know-how in developing countries, it is thus essential that process evaluation of measures newly implemented there should be carried out.

In short, we can draw three methodological conclusions:

1- What illustrates the difference between industrialized and developing countries from a safety point of view is not so much accident situations as the intermediate variables involved in accident processes.

2- The "blackbox" approach to safety work, which can be summarized as four successive phases (recognition of an accident situation - catalogue of possible countermeasures - choice of measure - implementation and product evaluation) is not adequate in developing countries, at least so long as the catalogue of known measures relies on product evaluations carried out in industrialized countries.

3- Process evaluation of measures (or sets of them) designed and implemented in developing countries needs to be systematically carried out.

As a result, we need to adopt a "glassbox" approach at a much earlier stage in developing countries than in the industrialized world. Safety work should encompass the following steps:

- construct safety measures in line with accident causation processes: identify accident factors generating critical accident situations, select some of them as intermediate variables and identify ways to influence them, design a set of measures accordingly, investigate possibilities of adverse side-effects.

- evaluate safety measures: implement the set of measures according to plan, perform process evaluation in order to check influence processes as well as appearance of adverse side-effects, perform product evaluation (when possible) to check and measure accident reduction.

- collect and compare information obtained from different evaluation studies and produce educational material for safety professionals and researchers.

This method of work requires, at least to start with, quite a lot of research, which is all the more time consuming as safety research teams in developing countries need most often to be organized and trained. But the amount of basic research necessary will obviously decrease as knowledge builds up. Besides, it is cheaper to perform good basic studies than to pay for countermeasures that may prove inefficient after several years of implementation.

Safety evaluation in developing countries

"Process" evaluation is made necessary by the very nature of traffic safety work in developing countries. Once this hypothesis established, we find out that there are also practical reasons that often make "process" evaluation more feasible than "product" evaluation.

1- There are methodological problems related to "product" evaluation, that may in some cases eliminate all possibilities of performing a reliable study:
- some basic difficulties, which are not specific to developing countries, are caused by the randomness of the accident phenomenon (regression-to-the-mean effect, accident migration, etc.), the lack of proper criteria to define controls, and the relative scarcity of accident data (comparisons of small numbers); these difficulties are made worse by poor data quality and accident under-reporting.
- evaluation of the effects of countermeasures cannot produce significant results when statistical data describing the accident situations concerned is incomplete or not detailed enough for changes to be measured; in developing countries, accident statistics are very often of poor quality (incompleteness, over-simplification of information) or not reliable over a period of time.
- product evaluation is a long-term prospect for some types of countermeasures that need time to show tangible effects (child education, improvements in drivers' training, etc.), and methodological difficulties arise that are not restricted to developing countries; however, they are aggravated in the latter by the fact that fast changing motorization and mobility conditions do not allow for any effects of a given measure to be still identifiable after an adequate number of years.
Product evaluation requires a qualified team with adequate knowledge of current statistical evaluation methods. One distinct advantage (there had to be one !) is that it relies only on existing data, which means that no additional funds are needed for specific data collections.

2- There are some practical advantages to "process" evaluation, but also some setbacks:
- evaluation procedures rely on the observation or measurement of changes to intermediate variables rather than accident figures; data recording is therefore carried out on an ad'hoc

basis and does not usually call upon existing (or non-existing) statistics; moreover, results are usually available after a short time (a few months after implementation of countermeasures).
- data recording is always possible with minimum equipment, but requires manpower, which is usually in adequate supply and does not cost too much (yet); proper training of observers and surveyors is essential to ensure validity of evaluation results.
- even more than "product" evaluation, "process" evaluation requires qualified professionals or experts to design the study on the basis of appropriate intermediate variables, train the data-collection team, monitor the surveys, and analyse results.
- specific funding is needed for ad'hoc surveys, which usually competes with further implementation phases.

Altogether, "process" evaluation is technically easier to perform than "product" evaluation in developing countries as procedures adapt more easily to local conditions; however, it is often ill-perceived by decision-makers as the marginal cost involved is obvious, and it does not provide direct bases for economic assessment of countermeasure effects.

So long as transferable evaluation results are not available in developing countries, the whole "glassbox" approach, involving extensive diagnosis of accident factors and detailed design of safety measures or policies to suit each individual case will have to be carried out. It will ensure at least reasonable probability of efficiency through rational construction of safety policies.

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