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Vitiate of Traffic and Transportation on Roads and Regulatory Measures

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Abstract – In the last century, there have been vast improvements in the living conditions and economic wealth of the industrialized nations of the world and, as a result, large population growth, particularly in urban areas. The growth of cities and towns has also led to an increase in the need for mobility and the volume of vehicles occupying road infrastructure. Statistics indicate that the volume of road traffic has increased threefold over the last 30 years and that the number of road fatalities has decreased by half. However, the increase in the number of vehicles far exceeded the expected capacities and adaptive capabilities of the existing road infrastructure, particularly in large cities, leading to a deterioration in traffic performance and increasing difficulties in maintaining an acceptable and sustainable safety standard. This situation calls for better use of the existing road infrastructure and has highlighted the role of transport planning and road engineering as a means of optimizing and balancing the key objectives of the traffic system concerned with safety, accessibility, capacity, performance and environmental issues and meeting the needs and demands of the various road user groups, given the limited resources available.

- X -

INTRODUCTION

The problem appears to be one of the global proportions of traffic fatalities rated as the ninth most common cause of death, according to statistics presented by the World Health Organization, and is likely to increase in the near future as a result of the development of third world countries. The global traffic safety situation has also been described by the Red Cross as a "global disaster."

Scope of the traffic safety issue According to statistics from the European Commission based on EUR-15 for the 15 Member States that existed prior to the addition of the 10 new countries in May 2004, the safety situation based on the 2002 statistics can be summarised as follows:

- 1.3 million road accidents a year
- More than 40 000 fatalities per year (definition includes deaths occurring within 30 days of a road accident)
- Approximately 1.7 million injuries per year
- Estimated direct and indirect costs: EUR 160 billion (equal to 2% of the EU Gross National Product)
- Accident figures from the 10 new countries that joined the EU in 2004 suggest an estimated additional 12 000 fatalities in 2002.

A closer look at the annual EUR-15 statistics shows that certain categories of road users are particularly vulnerable, including:

- Road users between 15 and 24 years of age (10 000 fatalities)
- Pedestrian (7000 fatalities)
- Cyclists (1800 dead)
- Motorcycles and mopeds (6000 dead)

Excessive or improper speed is estimated to be associated with 15,000 fatalities, drinks, drugs or fatigue in 10,000 fatalities, and the non-use of seat belts or helmets in 7,000 deaths. Excessive or improper speed involves more than one-third of all accidents and drinks, drugs or fatigue in as many as one-quarter. The relative risk of fatality in European traffic is far greater for vulnerable road users (pedestrians, cyclists, mopeds and motorcycles) than for drivers or passengers. The statistics on accidents elsewhere are equally troubling. The United States reported a similar number of fatalities (43 000) compared to the EUR-15 Member States, along with a significant number of injuries (2.9 million) in 2002. The estimated economic cost in relation to road accidents in the USA was estimated at around USD 230 billion by the NHTSA (2004), which is almost 50 % higher than that estimated for the EU. The scope of the problem is further illustrated by a comparison of injury and fatality statistics for 32 OECD member countries (see Figure 1.1 below).

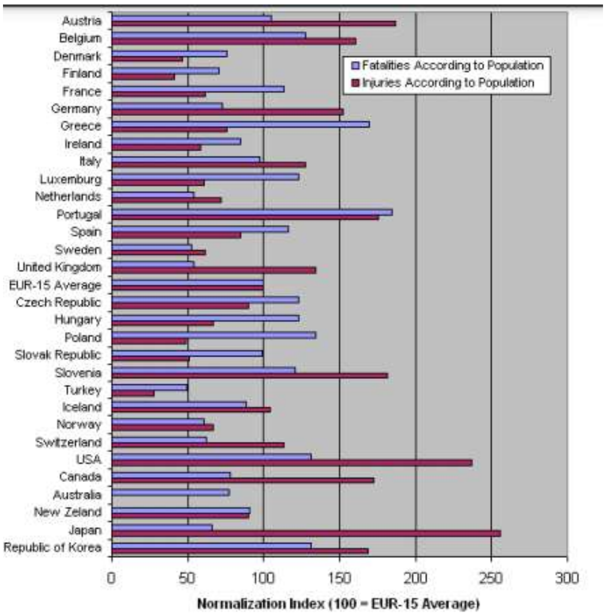

Figure 1.1 Fatality and injury rates in accordance with national population, normalised against EUR-15 average values

Traffic safety research from a historical perspective

- How do we classify safety critical events when accidents almost never happen for the same reasons, but rather a combination of many factors?
- How do we deal with the issue of road safety studies when accidents are very rare occurrences in relation to traffic exposure? The question of the relevant variables, how they are measured and how the "relevance" is determined must also be asked.
- Do we have full knowledge of the cause of an accident to deal with the problem of prevention of an accident? Accidents can be prevented by eliminating known hazards and by redesigning the infrastructure without knowing the exact nature of the actual cause of an accident. Scientifically, this relationship is important, calling for operational prevention measures and a combination of traffic safety knowledge and research methodology.

General Systems Theory as an descriptive approach to traffic safety

If a General Systems Theory approach is adopted to study the traffic system, the complexity and dynamic processes can be explained by interactions and relationships between road users, vehicles and road components at the highest level of abstraction. In view of the main concepts of this theory, an illustrative diagram of the basic elements of the traffic system is shown below in Figure 1.2.

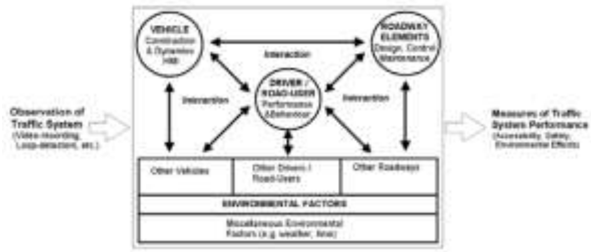

Figure 1.2 A conceptual model of the key elements of the traffic system

Traffic safety measurement and analysis

Use of historical accident data: Traffic safety is commonly measured in terms of the number of traffic accidents and the consequences of those accidents in terms of the severity of their outcome. While this historical data approach is useful for identifying specific safety issues at national and regional level, it is considered to be a 'reactive' approach which implies that a significant number of accidents must be recorded before a specific safety issue is identified and remedied using appropriate safety measures (see e.g. Lord and Persaud, 2004). A further drawback to this approach concerns the quality and availability of accident data and the time-frame needed to statistically validate the success of various safety-enhancing measures, given the random and sparse nature of road accidents. Furthermore, since the occurrence of an accident is usually the result of a complex and dynamic chain of events, it is often difficult to carry out safety analyses on the basis of statistical data and poorly documented accident database records which reveal little qualitative information on the underlying causes of the accident.

Proximal safety indicators as an alternative approach: a more effective safety assessment strategy is likely to involve the use of proximal safety indicators that represent the temporal and spatial proximity characteristics of unsafe interactions and near-accidents. The main advantage of such measures is their resource-effectiveness, given that they occur more frequently than accidents and require relatively short observation periods in order to provide statistically reliable results. Proximal safety indicators are particularly useful for pre-and post-

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study designs where emphasis is placed on the assessment and comparison of safety enhancement measures in specific traffic installations and, in some cases, on interactions between specific categories of road users. Methodologies used to collect safety indicator data also make the results sensitive to site-specific elements related to road design and dynamic and complex relationships between different traffic variables, such as average speeds, traffic flows and rotational movements.

Traffic safety modelling

Descriptive models – These are most commonly based at the system level and are based on two main sources of information: traffic accident data and exposure data. Problems with such models are often linked to the availability and quality of both data types. An example of this is the Rumar (1985) model, which describes the traffic safety situation in terms of exposure, risk and accident consequences.

Predictive / Analytical Models – Used to predict how changes in independent variables are expected to influence dependent variables in accordance with mathematical models that describe these relationships. Predictive models are often used to estimate the effects of specific counter-measures and alternative road designs as an alternative to pre- and post-accident studies requiring an unrealistic and impractical period of data collection. This type of modelling is most advantageous when there are a large number of experimental variables in combination with influences from different sources that are difficult to control experimentally. The literature suggests that many models suffer from a lack of flexibility and lack of a sound theoretical foundation, which restricts predictive ability and generalisation possibilities.

Risk models – The main objective of these models is to identify and quantify risk factors that explain and predict the behaviour of individual road users and to conduct safety assessments based on the risk-reduction effect of various counter-measures. Two main approaches can be identified: an analytical, system-oriented approach that seeks to identify risk factors and to identify mechanisms that act on the occurrence and severity of accidents; and a quantitative approach that seeks to estimate different effects on the basis of risk calculations. The problem with many risk models is that they are often too specific and context-dependent, without consideration for other important elements of the traffic system.

Accident Consequence Models – The main objective of this type of model is to reduce the consequences of accidents by identifying influential factors, such as those related to the road environment, vehicle safety and emergency services; or, alternatively, by promoting safety equipment or influencing driver behaviour. For this purpose, qualitative in-depth analyses are often conducted in accordance with special evaluation methodologies. Accident consequence approaches also include intervention strategies, such as the introduction of legislation and policies on speed control, alcohol and drugs, the use of seat belts, etc.

Modelling approaches based on traffic simulation

The simulation modelling is a particular type of predictive / analytical modelling that is becoming increasingly popular for traffic analysis purposes in the field of transport planning and traffic engineering. Traffic simulation models are designed to represent, mathematically or logically, the behaviour of the traffic system at different levels of abstraction in order to generate a quantitative description of the performance of the system. Simulation has become an effective tool for analysing a wide range of complex and dynamic traffic-related problems that cannot be studied with sufficient accuracy using other more traditional analytical methods. According to Lieberman and Rathi (2001), a traffic simulation is useful for the following purposes:

- Evaluation of alternative treatment
- Testing and visualisation of new designs
- An important part of the design process
- As an integrated part of other tools for traffic analysis
- Training of personnel (e.g. traffic control centres)
- Analysis of safety

CONCLUSION

The comparisons and analyses carried out as part of this work suggest that the Traffic Conflict Technique is currently the method with the highest potential for safety analysis. However, this technique may be successful in the future if automated video analysis techniques are a viable alternative for safety assessment purposes. On-site observation is, and should remain, an important qualitative part of current and future safety analysis methodologies. The work presented here also highlighted the need for a better understanding of the relationship between safety indicators and other variables (such as speed and speed variance, traffic flow, traffic composition, rotational percentages) and important behavioural processes (such as gap-acceptance and car-following) in order to establish a more comprehensive safety perspective. Such information is also used to identify effective and sustainable safety solutions. Developing statistical models that adequately predict the number of

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accidents on the basis of safety indicators will also add value to future safety analysis work, given that cost-benefit analysis is generally used as a basis for decision-making on investment and development in road infrastructure. In order to develop such models, an appropriate national database is needed that is accessible to safety analysts and modellers.

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