THE POTENTIAL OF ACCIDENT ANALYSIS SYSTEMS FOR THE EVALUATION OF ROAD SAFETY MEASURES IN EUROPE

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ABSTRACT

This objective of this work is to identify the potential of accident analysis systems for the evaluation of road safety measures in the European countries and elaborate solutions for the necessary improvements on quality and uniformity in data collection and analysis. The national road accident data collection and processing systems from several EU countries are considered and the possibilities and limitations for macroscopic road accident analysis are revealed. Additionally, a comparative assessment of selected accident analysis systems destined also for the evaluation of road safety measures took place, which led to the identification of the parameters for the development of the appropriate systems. A set of recommendations for future actions for the improvement of accident analysis systems in Europe is proposed, aiming to contribute to the implementation of more efficient road safety measures.

Key-words: road safety, road accident analysis, road safety information systems, accident analysis systems, road accident data, safety measures evaluation

1. INTRODUCTION

The evaluation of road safety measures effectiveness requires not only reliable input data related to accidents and respective exposure, but also appropriate analysis methodologies[i]. An important work effort has been dedicated over the last decades on the collection and the analysis of accident data at national and international level. A number of problems have already been faced with success but a number of other problems (underreporting, international compatibility, etc.) remain to be solved.

This paper presents the outcome of work carried out in the framework of the DUMAS project (Developing Urban Management and Safety)[ii], a European co-funded research project, having as objective to identify the potential of accident analysis systems for the evaluation of road safety measures in the European countries and elaborate solutions for the necessary improvements on quality and uniformity in data collection and analysis. The assessment of the national potential for accident analysis can help preparing a number of proposals, in the form of guidelines, for the improvement of road accident analysis in Europe.

More precisely, the national road accident data collection systems (collection techniques, data form, disaggregate data file, data definitions and quality, etc.) from nine EU countries[1]

[1] Austria, the Czech Republic, Denmark, France, Germany, Greece, Italy, the Netherlands and the United Kingdom

are considered, together with the respective national data processing systems (data bases, analysis techniques and methodologies, etc.). Examples from selected countries are presented, and the possibilities for comparable data and common approaches are examined.

Additionally, a comparative assessment of selected accident analysis systems destined for the evaluation of road safety level and related measures follows, allowing for the identification of possibilities and drawbacks of these analysis systems. Finally, a set of actions for the improvement of accident analysis systems in Europe is proposed, aiming to contribute to the implementation of more efficient road safety measures.

Information has been collected using of a questionnaire specially designed for this work, which was filled in by the DUMAS partners for their respective countries[3]. The answer to the questionnaire was often a monograph with the description and evaluation of the existing road accident data collection and processing system of each European country, coupled with the description of specific accident analysis systems[iii, iv, v, vi, vii, viii, ix, x, xi, xii, xiii, xiv, xv, xvi]. The use of the questionnaire allowed the comparative analysis of the various characteristics of the national and the specific accident analysis systems. Finally, large bibliography has been collected and elaborated allowing for the further analysis of the national systems.

2. THE NATIONAL DATA COLLECTION AND PROCESSING SYSTEMS

2.1. Road accident data collection

In all countries considered, road accident data are collected by the Police. When called to an accident, the police draw up an accident report if there is a casualty. In some countries (the Czech Republic, France, Germany), the police draw up an accident report also for material damage only accidents, when the damage is serious, exceeding a certain cost. In Italy material damage only accidents were recorded up to 1991 and in Austria up to 1994.

Accident data, referring basically to persons seriously injured, are also collected by the hospitals. Although limited in number and content, these files are frequently used for cross-checking data collected by the police. These cross-checks reveal very often important discrepancies between the two data sets and allow for the identification of the degree of accident underreporting of the police records.

In all countries considered, the insurance companies centralise road accident data, basically claims, at national level. The files of insurance companies provide information on damage only accidents. However they are not exhaustive, as at least two large categories of accidents are not comprised: single vehicle accidents of vehicles without omnium insurance and accidents with minor material damages in which persons involved prefer direct compensation than insurance involvement. In practice, many damage only accidents are reported by the police only in order to determine the question of responsibility. Experience from all countries collecting data on material damage only accidents shows that these accidents present the highest degree of underreporting. In general, data form insurance companies are not used for accident analysis because they do not provide the necessary information in electronic form (e.g. location of the accident) and because of confidentiality problems of these business sensitive data.

In countries where damage only accidents are not recorded by the police, some information on such accidents may be obtained through insurance companies. This may be useful for small scale accident analysis e.g. for identifying black spots, because material damage only accidents are by far more numerous than accidents with casualties and therefore allow for a better statistical analysis, especially in urban areas where they occur more frequently.

Finally, detailed road accident data collection takes also place in the framework of in-depth analysis for the investigation of accident and injury causation. These analyses do not intend to be exhaustive or representative of the accident occurrence in the country. They aim at the in-depth analysis of the causes of the accident and of the injuries by examining in detail all the circumstances just before, during and just after the accident. Very often these analyses are commissioned by the automobile industry in the framework of their efforts to improve active and passive safety of vehicles. Such analyses are under progress in the framework of European co-operation and research projects, in Germany (BASt), in France (INRETS) and in Italy.

2.2. The road accident data form

In most of the cases, the Police carries out an on-site investigation and fills-in on the spot an autopsy report, whereas it fills-in the road accident data form later-on at the police headquarters. Furthermore, in most of the cases, the accident forms are kept at the police headquarters (at least for one month) and are finalised with the necessary updates for the persons killed within 30 days from the day of the accident.

In some cases, the police fill-in additional data collection forms destined to other services (at local or national level). For example, in the United Kingdom, some police forces do collect additional information for their own use, but because of difficulties in collecting these data, this is not a requirement of the STATS19 form. In Greece, except for the data collection form destined for the creation of the national data file, the police forces fill-in two additional forms, one destined for their own purposes and one for use by the Ministry of Environment, Planning and Public Works. In Austria, the Ministry of Home Affairs runs an additional aggregated database on fatal accidents featuring accident causes and circumstances; each fatal accident is reported by the police to the Ministry via electronic link.

In every country, all or almost all basic accident data variables are included in the road accident data form. However, the values contained in these variables present important differences between the various national accident data collection forms. The basic accident data variables can be summarised in the following five broad categories:

- General information (time and location). Year, Month, Day of the week, Hour, Location.
- Road user. Age, Sex, Road user type, Alcohol consumption, Seat belt use, Car passenger position, Driving licence category, Date of Issue and Nationality.
- Road environment. Road type, Road category, Weather conditions, Lighting conditions, Road surface, Road surface conditions, Traffic control.
- Vehicle. Vehicle type, Vehicle age, Nationality.
- Accident. Accident type, Manoeuvre type.

The road accident data form is revised frequently (at least once every ten years) in order to better cope with the new needs of road accident analysis. These revisions can be simple additions of new data elements (e.g. existence of airbag facilities) or general restructuring of the form. In case of such general restructuring of the data collection form, special attention is given (not always with success) to the compatibility of the data series before and after the restructuring. Even though European level road accident data analysis is intensified lately, no European level initiative for harmonising the national data collection forms exists today.

2.3. The national road accident data file

Road accident data collected are forwarded following the police hierarchy and centralised to the administration responsible for the national road accident data file. This administration has different profiles in the various European countries; it can be the National Statistical Office, the Ministry of Interior, the Ministry of Transport, the Ministry of Justice, etc. Furthermore, this administration is fitted to the national administration system in different ways in the different countries, a fact that determines not only the incoming data flow but mainly the outcoming data flow (which services have access and under which conditions, etc.). In some countries (Germany, Austria) road accident data files are also maintained at the administration of the local Government (Laenders, etc.)

When accident data are transferred to the central computer, a series of checks and validations takes place correcting errors before the data introduction into the computer. These checks take place at periphery level but also at central level just before the data introduction into the central computer. Furthermore, in most cases there exist quantitative targets for the timely reception of the data. For example in the United Kingdom, data should be received no later than three months following the end of the month to which they relate, whereas in Denmark data should be received within 5 weeks after the accident.

The electronic transmission of accident data from the local police to the central data file is a new trend. For example, in Denmark and in Italy, a number of local police forces fill-in a computerised accident data collection form and then forward this information by electronic means (mainly on a disk). The electronic transmission of accident data is an issue seen positively for future development in most European countries.

The structure of the national road accident data file varies between the various European countries. In most of the countries, there exist at least two sub-files: accident file and person file whereas in some countries there exist also separate sub-files for the vehicle and/or the road. Furthermore, in some countries there exist links between the national road accident data file with other national data files (vehicle registration file, driver licence file, road network file, etc.) allowing the combination of accident data with more detailed and accurate information about the vehicle, the driver and the road network (United Kingdom, Denmark). In some cases, links also exist between the national road accident data file and national exposure data files (vehicle- or passenger-kilometres) allowing for the formation of accident indices (relating accidents to the traffic) which better describe the road accident phenomenon.

2.4. Data quality

The quality of data is always a delicate subject for those using statistical information[xvii, xviii]. Accident data files present various data quality problems, which create limitations for data analysis. In particular, not being able to reasonably exclude the possibility of errors or omissions, it is good practice to try and establish the frequency and extend of these situations. The basic road accident data quality problems found in the data files of the countries considered were examined.

Accident underreporting may create a bias in the analysis towards fatalities and the more serious injuries or towards certain types of accidents, where the underreporting is smaller[xix]. Sometimes, accident data can be adjusted in order to take underreporting into account. For example, underreporting is more frequent in the following types of accidents, in order of importance: a) light collisions, even with serious consequences, b) knocking into or over pedestrians, often with injuries due to falling, c) falling off two-wheel vehicles (accidental falls -even due to trying to avoid collisions with other vehicles-, collisions with parked vehicles -even due to door being opened suddenly-, collisions with moving vehicles), d) passengers falling off at the bus stop, either because of bus starting too soon or doors being closed too quickly, e) passengers falling or thrown from seat inside the bus due to sharp braking or collision with another vehicle.

The exact identification of the accident location is not an easy task for the Police and very often related collected information is either wrong or inaccurate. The accuracy of the identification of the accident location varies considerably among countries but also among the various types of road networks inside and outside built-up areas. For example, in France it is estimated that missing locations represent 17% of the total number of accidents (4% in large towns) and that about 20% of the total number of accidents has an accuracy level of accident location exceeding 100 metres. In the United Kingdom, the use of the Ordnance Survey Grid Reference method (information is mapped onto the national road network) makes the location identification more accurate. The use of Geographic Positioning Systems (GPS) started to provide the necessary accuracy in the recording of the accident location, whereas Geographic Information Systems (GIS), already used in some of the countries considered, contribute to a systematic recording of accident locations.

In most of the European countries information about the presence of alcohol in the blood of the driver must be filled-in in the road accident data form. However, alcotest is not always taking place mainly due to technical problems, like the transportation of the persons injured or killed in a distant hospital, or the non availability of the necessary alcotest equipment. Furthermore, even if the alcotest took place, the results (available only some days after the accident at the hospitals) are not always included in the form, given the complexity of the administrative procedure necessary for the forwarding of the information from the hospitals to the responsible police authorities. For example in France, information about alcohol consumption by the driver is available for about 50 percent of the accidents reported whereas in Greece this percentage does not exceed 2 per cent.

Inaccuracies in reporting the various values contained in the national road accident data files considered are also observed. Inaccuracies are increasing due to the lack of proper training of the police force collecting the information.

Definitions of the road accident values contained in the national accident collection form and in the respective national files present important differences among the various European countries. Even for basic concepts as the definition of persons killed, important differences have been observed[xx]. The uniform international definition of persons killed in road accidents as the persons who died within 30 days from the day of the accident is used in most of the European countries, except for the following South European countries which use different definitions: 6 days for France, 7 days for Italy and 24 hours for Spain (up to 93), Greece (up to 95) and Portugal (up to 97). Special correction factors are used by these countries for the conversion to the uniform UN definition[xxi,xxii]. Additionally, definitions of injury severity present important differences among the various EU countries as the minimum injury in order that an accident is recorded is different in each country.

2.5. Access to the data file

Access to the national road accident data file suffers by data confidentiality problems. Not all data are accessible and there exist several different arrangements for accessing the data.

The most usual way of accessing data is through requests to the competent organisations who provide aggregate results, most often in paper form. However, in every country there exist few specialised users who benefit exceptional privileges, like the direct or indirect access to the disaggregate national data base, etc. These specialised users are in most of the cases public organisations with a particular implication in road safety (national research institutes, ministries, local authorities, etc.). Additionally, in some countries, local authorities have under certain conditions, access to the national files. However, in most of the cases, the local authorities are not in the position to exploit the huge potential of the national data files. The most common way for local authorities to access accident data is through the files of the local police authorities collecting accident data, with which they have a well established co-operation on several policies including road safety.

Since 1995, access to the national disaggregate road accident data file has been granted to authorised administrations from some EU countries in the framework of the EU CARE project under the reciprocity principle.

2.6. Output services and users

Each national administration maintaining the national road accident data file provides a series of data output services. These services comprise an annual statistical yearbook (exists in all EU countries) as well as periodical (monthly and/or quarterly) and customised reports answering not only to the standard demands of most of the users but also to the specific demands from the very few specialised users. These yearbooks and reports are mainly on paper form and recently are also provided in CD-ROMs (few countries). Today, in most of the countries, the statistics' users can have access to basic or extended road accident figures (aggregated Tables) through the internet website of the authority maintaining the data file.

Road accident data analysis can concern general macro-analysis or very specific micro-scale analysis depending on the needs of every particular user. The several different types of users as well as their needs found in the various European countries do not present, in general, important differences. The five basic categories of road accident data users at national, regional and local level, are:

- National Public Administration
  (Ministries of Transport, Public Works, Public Order, Justice, Interior and Health, Statistical Office, Local Authorities, Police, Hospitals, etc.)
- Research and Scientific Institutions
  (Universities, Public and Private Research Institutes, etc.)
- Industry
  (Vehicle Industry, Road Construction Industry, Other Industries)
- Professional and Other Associations
  (Road Users' Associations, Consumers' Associations, Touring Assistance, Insurance, Disabled People Associations, Institutes for Alcoholics, etc.)
- Mass Media
  (Newspapers, Magazines, Radio, Television, Internet, etc.)

2.7. Accident analysis and safety policy

Road accident analysis is useful for the identification of road safety stakes. That is only a part of the information taken into consideration in the decision process which also depends on the political preferences. Very often, road accident analysis provide quantitative results for the evaluation of safety efficiency road safety measures. In some cases, road accident analysis results are used to justify safety measures already decided and publicly announced. Finally, road accident analysis at national level allows for the setting up of quantitative targets in the framework of a national road safety policy.

Road accident data are also useful for local authorities who use them to discover the characteristics of road safety in their areas. Individual cities, towns, villages, roads can be all analysed to determine road accident levels and severity. This information can then be used by the local authorities in their road safety plans and policies (black-spot identification and treatment). The degree of consideration of road safety issues in the urban and non-urban transport planning process varies considerably between the European countries but also between the regions and towns of the same country. As transport is also an urban authority responsibility, the way of taking road safety issues into consideration in the urban decision making process depends directly on the local policies and practices.

As far as road safety audits at national, regional and local level are concerned, the situation is very much diversified in the various European countries. Some Northern European countries have developed the last decades safety audits which can be considered rather systematic for the areas they concern. For example, very often, in large towns in France, the road safety department has to give some advice about each new road design. However, the road safety audit concept in Europe is not yet sufficiently mature and several problems are frequently faced. These problems can be technical (what to be controlled and how?), or related to the assessment of the safety benefit (do the places presenting high frequency of accidents present also high accident risk?, can the audit results lead to an actual safety improvement of the concerned road?), or to legal or competency aspects (consequences on legal responsibility of authorities, responsibility share among local, regional and national authorities). In the Southern European countries, safety audits are carried out less systematically, which can be explained also by the fact that road safety policy does not present an integrated approach comparable to the one of the Northern European countries. However, there exist several cases in Southern European countries where some fragmentary safety audits gave interesting results.

It is noted that in some countries there exist also audits for road safety management. For example in France, the Ministry of Public Work and Transport carries out audits on the position of road safety in the decision making process of the public services at national, regional and local level. The aim of this audit for road safety management is to identify the way of taking road safety into consideration, the involved services, the evolution of the knowledge, the know-how and the practices.

3. SELECTED ROAD ACCIDENT ANALYSIS SYSTEMS

One of the most important efforts to improve road safety is the development of information systems that would support the planning, design, construction, maintenance and operation activities for road safety. The major goals of such information systems can be summarised as follows : keeping track of accidents, providing consistent information support for analysing their causes and predicting their evolution, proposing measures to increase safety and analysing the impact of the implementation of such measures. The design, development and implementation of proper Accident Analysis Systems, has to deal with the following :

- variety of user types and hence, multiplicity of requirements, with reference to the data collection and analysis techniques,
- enormous data requirements, which lead to costly collection, storage and analysis procedures,
- duplication of effort in data collection and storage by multiple agencies,
- use of inconsistent methodologies,
- production of conflicting reports.

In the above context, various systems have been developed and are maintained in the European countries. Most of them are implemented by an official organisation or agency (i.e. Department of Transportation, Statistical Agency, University etc.). The characteristics of some of them have been analysed and led to the identification of the necessary parameters of an accident analysis system.

3.1. System characteristics

In the UK, the accident analysis system is part of the national road accident database, according to the STATS19 form and has been developed by the Department of Transport. The Ordnance Survey Grid Reference data are mapped by the Highways Agency to show locations of accidents at the national level. This information is used to identify accident clusters and black-spots so that programmes of remedial measures can be devised. It is also used by the Highways Agency in the development and planning of new roads and traffic schemes as well as for the evaluation of measures implemented. At local level, the STATS19 data can be analysed to determine road accident levels and severity for individual cities, towns, villages, roads and junctions. The database allows the local authority to investigate the different road accident problems and implement and evaluate targeted countermeasures.

In the UK, another system called Micro-computer Accident Analysis Package (MAP) has been developed by the Overseas Centre at TRL[xxiii]. Its purpose is to enable developing countries to collect and analyse road accident data in a systematic manner with easy-to-use software. The programme is specifically designed to work on a PC and offers a variety of accident mapping facilities in which the location and severity of accidents can be plotted on raster scanned, vector or text maps. A useful feature of the scanned and vector mapping modules is that a selected area of the map can be isolated for separate analysis using the «polygon analysis» facility. Additional facilities allow the identification of the worst accident group or site within the accident database according to criteria defined by the user.

The French experience on the development of Accident Analysis Systems, includes two systems the AURORE (Accidents Urbains sur Ordinateurs) and CONCERTO (interurban network). AURORE has been developed by the DSCR (Direction de la Securite et de la Circulation Routiere - Department of road safety and traffic) and is being managed by the CERTU (Centre d'etudes sur les Reseaux, les Transports, l'Urbanisme et les constructions publiques - Study and research centre for networks, transport, town planning and public building). it is used for retrieval, horizontal and vertical sorting and queries for cross-roads accidents. The sorting may concern number of accidents or number of persons involved. It may be expressed in absolute value, in percentage or in evolution. It has been used for evaluation of interventions at the urban road network through before and after studies.

In Italy, the Department of Civil Engineering of the University of Brescia in collaboration with the City authorities have developed a system for the analysis of accident data and their location in the city. Accidents are located on a map and linked to the database with the aid of GIS. The data base is based on the accident statistical report, sometimes enriched with other information. The cartographic location of the accidents presents many potentialities : to put in evidence areas with the biggest number of accidents, evaluating the historic evolution, giving public administration an instrument for deciding priority of interventions and providing a check tool for the analysis of intervention efficiency, by the comparison of the number and distribution of accidents during the years. This analysis allows to calibrate the action characteristics and to take the right steps forward.

In Greece, the Department of Transportation Planning and Engineering of the National Technical University of Athens in collaboration with the Ministry of Public Works, developed an information system for the analysis, monitoring and evaluation of road safety in the major road axes of Greece. The system provides statistical analyses, defines hazardous locations and the accident characteristics in these locations and evaluate the results of improvements. It can also estimate expected evolution of accident statistics according to existing trends. The analysis modules of the Greek system include the creation of general statistics, the identification of high accident locations (calculation of hazard index by the use of the quality control method), the execution of before and after studies for the evaluation of safety measures (chi-square and Bayes methods) and the prediction of number of accidents (damped - trend exponential smoothing).

The Austrian accident analysis system called UNDAT (**Un**fall**dat**enbank - Accident Database), has been developed by KfV - Kuratorium fur Verkehrssicherheit. It has steadily being further developed and improved since 1995, successor of the widely used KfV DOS-tool «Accident Information Data System». This information system is used for the production of general statistics, having the ability for flexible queries for all variables defined in the accident form and providing many user-friendly tools. A module exists dealing with the identification of black spots, according to the Austrian Guidelines on Black Spot Treatment. Crossings and road sections are not separated. A priority list is generated according to the similarity of accident, the number of injury accidents and the accident severity (slight injury : serious injury : fatality = 1 : 10 : 250). Furthermore, before and after studies for the evaluation of measures can automatically be performed at a 95% level of significance. Finally, the computation of accident rates (number of accidents per traffic volume, length and time) and densities (number of accidents per length and time) is also possible for given road sections. The system is used by KfV and its subsidiaries in all of Austria's nine provinces and it is also used by dedicated departments in the ministry for transport, other ministries, transport experts of province authorities and even by some municipalities.

The National Road Administration of Denmark has developed different accident analysis systems for interurban and urban road network. The system dealing with accidents on interurban roads allows the link between accidents and road data in an Oracle database. Various tools are associated to this system, (GIS, Black Spot programmes, Accident Analysis Systems for junctions and road links, etc.) At urban level, different PC-based accident analysis tools are used (Black Spot on PC, ROADMAN, etc.), depending on the size of the municipality. GIS-tools are used in most larger Danish municipalities, where all kind of information on housing, roads, drainage, accidents, traffic flows, road lighting etc. are collected and stored. It is aimed that the Danish system ensures more accurate data in the future and makes the Police a more active participant in the traffic safety work.

In the Czech Republic the PVT Litomerice in co-operation with specialists from the National Road Administration developed a software for black spot identification. This system may be used for black spot identification, through a priority ranking method. The National Road Administration uses this system for black spot identification, analysing two years period data with an one year step.

All the systems considered maintain one or more databases. An Accident data file is mandatory in all systems, which in general consists of three files concerning information on the accident (location, date, time, weather road and lighting conditions, road surface, accident type etc.), the vehicle (vehicle type, driving direction, nationality, make, engine power, year of production, manoeuvres, etc.) and the persons involved (person type (driver, passenger, pedestrian), sex, seat belt/helmet use, age, nationality, alcohol presence in blood, driving licence, injury severity, etc.). Other databases concerning the infrastructure, the traffic volume, the registered vehicles and the implemented measures, are the most usual but optional databases. In some more advanced systems, which also consider the geographical position of the accident, digital maps are also maintained.

Various types of analysis modules appear to be available. Most of them have to do with simple retrieval, sorting of requested data and general statistics, while other seem to be more sophisticated including black spot identification, before and after studies etc. All the outputs include tables and graphs of absolute numbers or percentages. In some cases these are predefined tables and diagrams while other systems have the capability to serve special requests of the user. Some of the systems also produce accident location thematic maps.

From a computer hardware/software point of view, these systems vary. Some of them are developed many years ago, while others, are implemented or upgraded recently and are operating on PC and/or mainframes. Software used concerns from simple excel and database packages to advanced relational database software, advanced statistics packages and specialised geographic information systems (GIS). Very often, not only important programming effort but also advanced network architectures are needed for the implementation of nation-wide accident analysis systems.

3.2. System development parameters

Trying to establish a common framework for the development and use of accident analysis systems, it is necessary to standardise as much as possible the types of inputs, outputs and processing methods. The analysis of the selected accident analysis systems as well as the results from the extensive bibliography review on such systems[xxiv, xxv,xxvi] have led to the identification of the necessary parameters for the design and development of an integrated accident analysis system supporting the evaluation of road safety measures. More precisely, the development of such a system should take into consideration the various types of users, the data collection and storage needs, the data bases linkage, the necessary processes and outputs and the measures evaluation particularities.

It is obvious that the input of the system depends on the requirements of its users. The first step is to examine who are going to be the users of the system[xxvii,xxviii,xxix]. Agencies and organisations, like police, insurance companies, courts, car industries, statistical agencies, public agencies (which deal with drivers' licences and vehicle registration), hospitals, universities and traffic engineers who may co-operate with any of the agencies mentioned above, are the most common types of users. It is really important, to decide the types of users, by the beginning of the system's design, because this will define its input, processing and output requirements.

Today advanced computer technology, in the areas of both hardware and software offers the capability of interacting with available data in a fast and efficient manner. At the same time, highway authorities policy and decision makers are demanding quick and accurate answers to their questions regarding the attributes and performance of the facilities within their purview. It is really important to determine each authority's competencies. Co-operation on an inter-authority basis as well as within authorities, will lead to avoidance of collection, process and maintenance of the same data in more than one systems. Partial duplication or redundancy in data collection and processing is often useful for verifying data quality by comparing duplicate data sets. Integration of data files provides many opportunities to eliminate duplication of effort and to obtain maximum production from a given data system.

The key to an integrated information system for road safety is the inclusion, in any data collection activity, of data elements that can be used as links to other files or sets of data. Such links permit the correlation of data from two or more sources. Although the scope and rate of the development of information systems varies widely from one organisation to another, a typical information system for road safety may have some common characteristics. In an effort to comprise as much data as possible and to satisfy as much needs as possible, vehicle data, traffic data, road data and, of course, accident data, should be used.

All the types of data are related to a location. This location may be a single point or a section of highway, defined by specific beginning and ending. It would be efficient indeed to develop a single record containing all types of data related to a single location. It is advantageous from a data utility and efficiency stand point to develop a separate specialised data set for each particular type of data. This data set contains only records for those sections of highway to which the data apply. Four basic types of data categories, are usually created[xxx]. The accident file, the road file, the traffic file and another general file which consists of additional information.

The key for the integration of data bases in the linkage among them. In an information system for road safety, the primary links are location references[xxxi]. File linkage can provide many benefits to the user of the information system. Substantial savings in time and manpower for performing routine accident analyses can result from this process. Another benefit is the capability to perform safety research studies or to investigate the effects of certain geometric features on accident experience. For example a link between the accident file and the traffic volume file, is necessary for the computation of accident rates at specific highway locations. The linkage of the accident file to the road file is also necessary for the assessment of the impact of various traffic and roadway features on the accident phenomenon.

Having a successful and flexible linkage system, many different procedures of analysis can be developed. These include simple statistical procedures, definition of geometric characteristics and accident rates, definition of high hazard locations, before and after studies, accident correlation with geometric, traffic or other characteristics, accident prediction.

An evaluation data file, must be maintained. This file will formalise the collection of the experience reflected by evaluations of countermeasures implemented throughout a region. Every location, where countermeasures have been implemented, must be included as a record of the file. Such a record consists of two kinds of site characteristics. Those before the implementation and those after the countermeasure implementation. A third component of the record refers to the results of the evaluation. Thus, the system may provide some indication of the possible effectiveness of proposed countermeasures.

4. CONCLUSIONS

Today there exist a great potential for road accident investigation at national level given that data are collected, processed and analysed already for decades. The evolution over the years of the national system for accident data recording and analysis allows today for reliable and useful analysis results to be produced at macro or micro level. Some effort should be put on the further enhancement of data reliability (underreporting, inaccuracies in location and alcohol data, etc.) as well as to the linking of police accident files with other accident files (hospitals, insurance companies) as well as with other data files (road network, vehicle fleet, vehicle mileage, etc.).

There is a growing need for road accident analysis at European level, which faces today several problems not only due to incomparability and unavailability of accident and traffic data but also due to the lack of European files to provide complete sets of data. However, the work of several initiatives in the field (CARE, IRTAD, etc.) has started to produce the first results allowing for basic pan-European comparisons. Additionally today, the road safety community can use existing national data and benefit from the exchange of experience among the European countries. The present effort to harmonise data at European level should be intensified in order to allow for meaningful comparisons among EU countries and cities.

Road accident analysis at local scale presents a diversified image. Local authorities disposing the will and the tools can use the powerful national system of accident data collection and processing in order to identify the road accident characteristics in their area and elaborate, implement and evaluate a plan with countermeasures for the improvement of the level of road safety. On the contrary, local authorities not disposing the means for appropriate road safety analysis can only benefit from the macroscopic analysis produced at national level.

Due to the different development and traffic patterns in the various European cities, European level road safety comparisons at the city macro-scale is a difficult task and may lead to erroneous conclusions. However, the exchange of experience between the various European cities can be very beneficial both for the road safety problem analysis and the implementation and evaluation of related countermeasures. When information on urban road safety problems is made public at European level, successful practices can be imitated whereas repetition of errors can he avoided.

Existing road accident analysis systems vary from very simple data recording systems to sophisticated integrated analysis tools and it is up to the end user to choose the system that best meets its needs. Their use in the road safety process is very useful specially for the identification of black spots as well as for before-and-after studies for the evaluation of safety measures. However, the strength of theses systems is limited today by the reliability of input data on one hand and by the relatively high development and operation cost on the other. A common framework should be established for the proper development of efficient accident analysis systems, standardising inputs, outputs and processing methods

The advent of information technology applications in road safety analysis started already to produce astonishing results. A much larger amount of information is processed whereas the results are presented in a more efficient graphical way (GIS), offering thus to the decision makers a better founded and larger range of alternative options to choose for the improvement of road safety.

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