The importance of a road accident data system and its utilisation.

by

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Abstract

From TRL's experience and overseas research programme in road safety, spanning almost 30 years, this paper presents a brief overview of current road accident fatality statistics of developing countries. It discusses worrying trends, under-reporting, socio-economic aspects of road accidents, and also common practices in safety improvement. Its main focus, however, is the importance of establishing a reliable road accident database and analysis system; road accidents being the fundamental measure of safety. Access to the database is thus an essential part of identifying, and hence targeting, specific safety problems and in evaluating the effectiveness of any measures introduced. The most important data items for accident recording are discussed and various examples of analysis systems presented.

1 Introduction

Before discussing the extremely important subject of road accident databases; by means of introduction some background of the UK's Transport Research Laboratory is presented together with a brief overview of why road safety is so important in the Third World.

TRL Ltd, the Transport Research Laboratory, is the largest and most broadly based centre for transport research in the UK. It currently has over 373 scientists and engineers covering all aspects of the transport sector from highway engineering to driver behaviour and environmental issues to road safety.

In addition to working in the UK providing a research service to the Department of Transport since the early 1930s, TRL has extensive experience overseas and carried out projects in over 50 countries over the last 3 years.

In 1992 it became an Executive Agency and customer controlled budgets replaced grant funding. This latter was more significant than the transfer to Agency status because it forced us to become customer focused. TRL was then privatised in a trade sale in 1996. It is a non-profit distributing company limited by guarantee; it has no shareholders and therefore no ownership bias and no dividend requirement. One of the Secretary of State's key objectives for the privatisation of TRL was to maintain the continuity of supply of high quality, independent and impartial research. Its turnover last year was £33.5M and this is expected to gradually increase over the next few years.

TRL has had an International Division or 'Tropical Section' (as it was known) since before the 2nd World War which specialised in roads and transport research for the needs of developing countries. It has been funded separately by the UK's Department for International Development (DFID) for many years and since 1973 it has had a small team specialising in the road safety problems of the Third World. The following section is based on some of the research findings of this team.

2 Overview

2.1 Road accident statistics

Road accidents are not reliably and regularly published by all countries of the world but accidents of the most severe form, those involving a fatality, are normally more reliably recorded than the other types. Recent research by TRL (Jacobs et al, 2000) has estimated that in 1999 about 750,000 people were killed in road accidents globally. Of most concern is that about 640,000 of these, that is, 85 per cent occur in developing countries or emerging nations. Hence there is a great need to focus efforts in the Third World.

Estimate of global road accident deaths, 1999

	Fatalities per year	Per cent
Highly motorised countries	110,000	15%
Developing countries	640,000	85%
TOTAL	750,000	100%

This extremely large number of people killed on our global road network would be the equivalent of two thousand fully laden Boeing 747 Jumbo jet crashes in a single year; that is, an average 5½ of these aeroplanes crashing every day killing all on board.

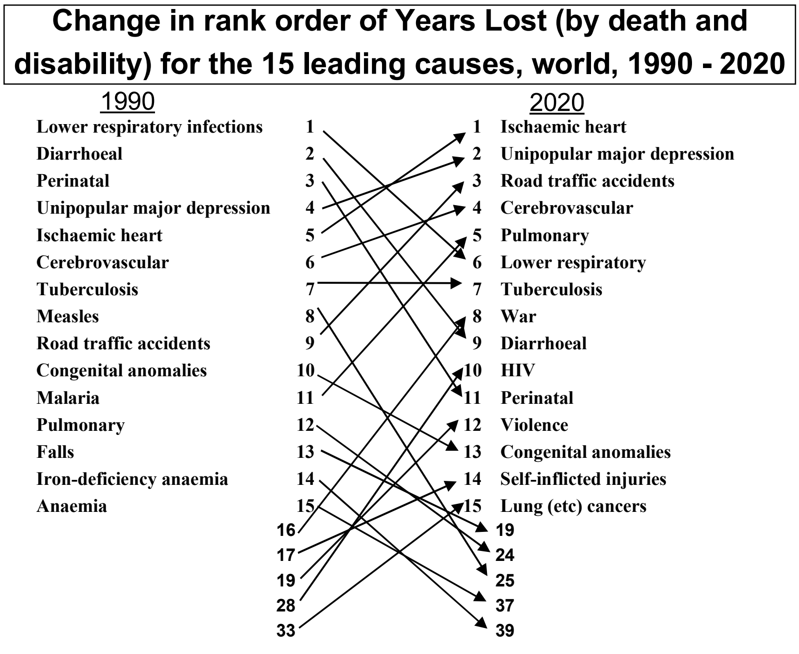


Figure 1

The World Health Organisation produced a report in 1996 (Murray & Lopez), which reviewed the main causes of death and disability throughout the world. In Figure 1 the left-hand side lists those causes in order of producing the most deaths in 1990. 'Fatalities due to road accidents' was then ranked as the ninth most important factor.

Based on a detailed analysis, the WHO made predictions of the situation for the year 2020 and the various changes in position are shown on the right-hand side above. Road accidents are predicted to rise to third place (after ischaemic heart disease and unipolar major depression). Thus the need to attempt to prevent road accidents by whatever means are effective will become increasingly important.

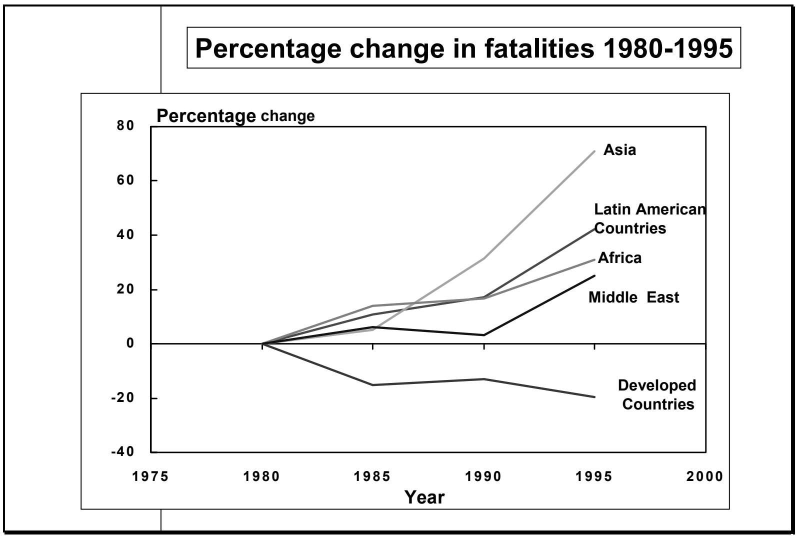


Figure 2

The situation in developing countries also appears to be a worsening one as the graph in Figure 2 shows. The lines represent the average change in road accident fatalities for sample groups of countries in the various regions over a period of 15 years. The Asian countries appear to have been the worst with an increase of about 70 per cent over this period and African countries over 30 per cent.

This contrasts with the situation in the more motorised or developed countries, which have experienced a reduction in road fatalities of about 20 per cent, on average, over this same period. Although these countries have not seen as rapid a percentage growth in traffic as the developing nations, they are still generally experiencing growing numbers of vehicles on the road each year. It is argued that the reason for their falling fatality numbers is largely as a result of the many efforts that have been made by various bodies in improving safety each year.

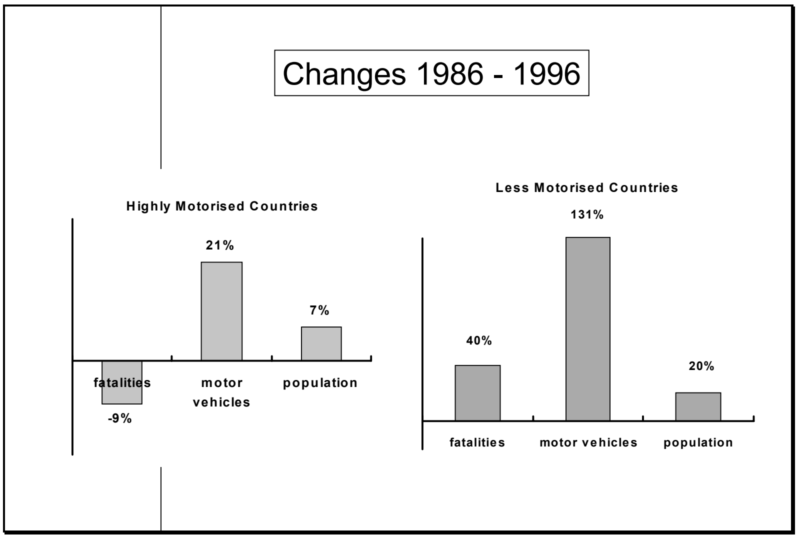


Figure 3

Figure 3 illustrates some of the problems for developing countries over a recent period of 10 years. Motor vehicles and the human population of a sample of highly motorised countries have increased on average by 21% and 7 % respectively whilst fatalities have been reduced by 9%. The sample of less motorised countries, however, have seen much greater increases in population - by 20 % over the ten years and a massive increase in traffic by 131%. Against this background it is not surprising that road accident fatalities have risen, and in fact these countries have seen them grow by 40%.

It is very difficult to make comparisons in relative road safety between countries due a number of factors such as the reliability of accident data, differences in ways data are recorded, differences in definitions (even over what constitutes a fatal accident: death within 30 days of the accident is not yet standard world wide). Also, it is very difficult to take exposure (to risk) into account as not all countries monitor (by means of regular surveys) average mileage's of the various road user groups.

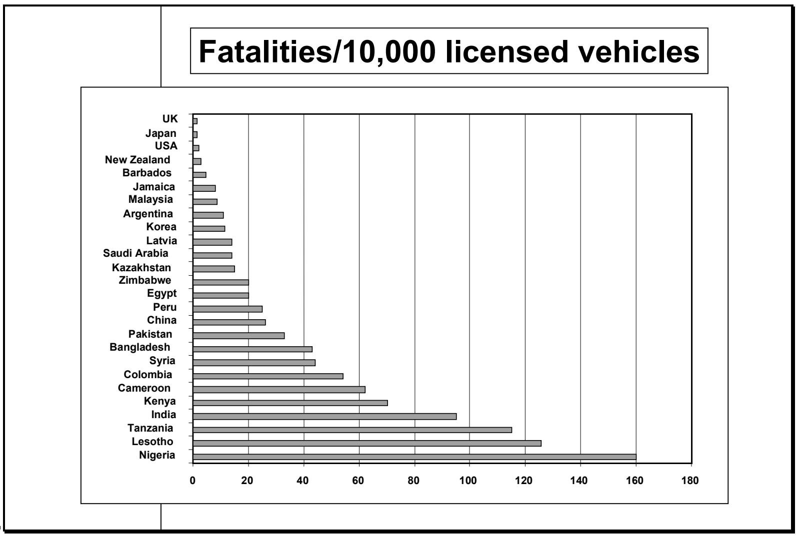


Figure 4

Although far from a perfect measure, deaths per 10,000 registered vehicles is a common statistic used to make such comparisons, mainly because these two variables tend to be widely and relatively well-recorded by most countries. Figure 4 clearly illustrates the wide difference in safety between different countries of the world. Developing countries tend to have much higher fatality rates than the countries of the developed world, which tend to lie at the lowest edge of the chart. Indeed, some African countries have accident rates up to a hundred times greater than, for example, the UK, Sweden or Japan.

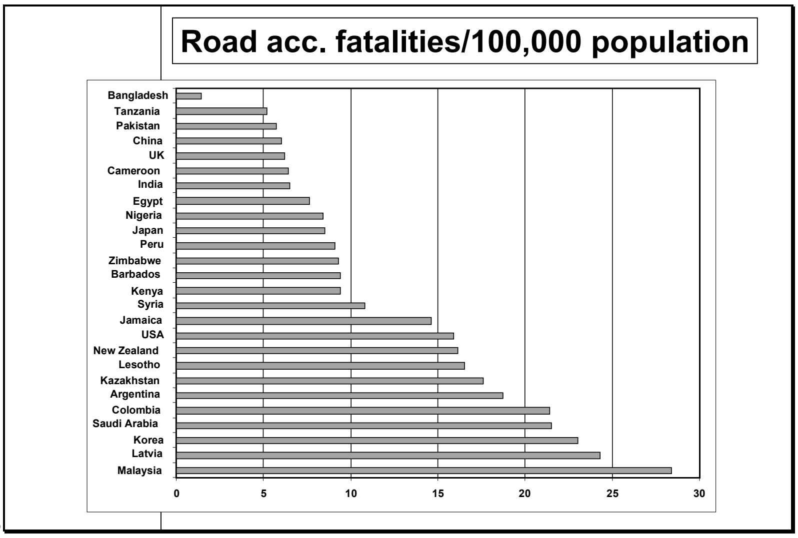


Figure 5

If, however, we compare another statistic, fatalities per 100,000 population (Figure 5), a country like Bangladesh with its relatively low numbers of vehicles but large population appears to be relatively safe. The developed countries move to a mid position in the above chart and a rapidly developing country like Malaysia, which is experiencing very high traffic growth in relation to its small population, appears to perform very poorly in this comparison.

What is clear is that whatever statistic is used there tend to be wide differences between different countries' safety and sometimes even between neighbouring countries.

There are many reasons for these differences they might include differences in culture, education, behaviour, driver training, vehicle modes and use (e.g. trucks used for transporting people and general overloading of public transport vehicles), vehicle and road condition, a different mix of vehicle types in traffic, and a higher use of rural roads by pedestrians than tend to be found in developed countries.

2.2 Socio-economic impacts

A survey of hospitalised road accident victims in seven developing countries (Ghee et al, 1997) has indicated that children up to the age of 15 constitute about 15 to 20 per cent of accident victims with boys in the majority in most of the 7 countries studied.

Socio-economic impacts

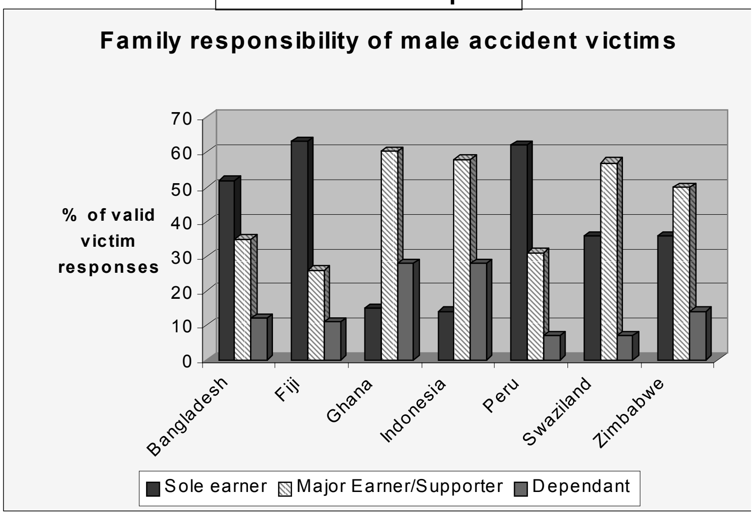


Figure 5

However, it is young economically active males in the age range 26-45 that were the largest accident casualty group, being well over-represented when compared with their proportion of the population distribution in all countries surveyed. The majority of these victims were married and, as Figure 6 shows, most were either the main earner or major contributor to the family income.

Socio-economic impacts

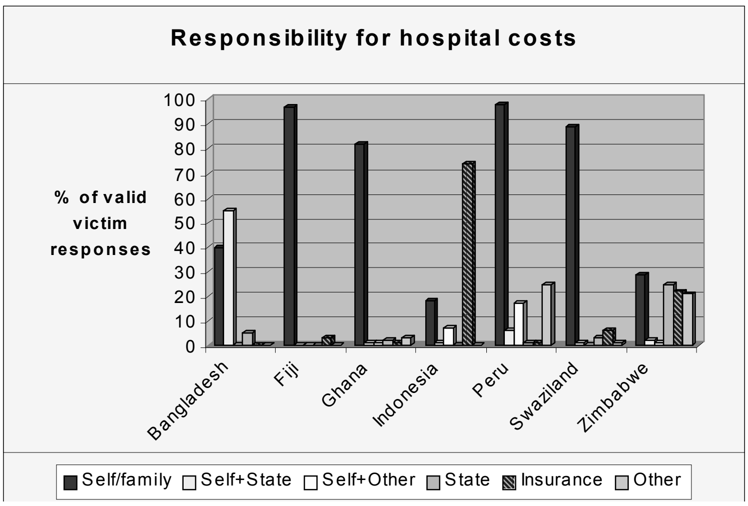


Figure 5

It was also found that the victim or their family had to pay for all medical treatment in all countries surveyed (see Figure 7), with the exception of Indonesia where costs tended to be covered by insurance. Very few victim's medical costs were paid for by the state (except in Bangladesh), and thus in the poorer families, the effect of a road accident to the head of family can have a dramatically damaging effect on the family's standard of living.

3 Road Safety Improvement

When thinking about ways of improving safety, therefore, we have to be careful about choosing appropriate measures for the particular problems that exist in a particular country or region. Accident countermeasures that have been found to work well in developed countries cannot always be expected to produce similar positive effects in developing countries because of these differences. It is important, therefore, to design appropriate safety remedial action and to evaluate that action to determine how effective various measures have been so that the best value for (normally scarce) funding available can be maintained.

The 3 E's of ways of road safety improvement are well known (Education, Enforcement and Engineering). A fourth E tends to have been added in recent years: that of Encouragement. This is generally regarded as a role for governments in creating the right safety culture for improvement in terms of setting up the best institutional framework and links for co-ordinating action, perhaps making regulations to force efficient safety management and, of course, providing adequate funding.

As a research establishment, TRL have added a fifth E, that of Evaluation. In order that money is not wasted we believe it important that all new countermeasures are tried initially as pilot schemes and these are properly evaluated and reported on for others to learn from. This should help to ensure that only those that do prove to be effective in a country are implemented on a wide scale.

This leads us back again to the importance of collecting and maintaining an accident database as the ultimate measure of how effective the remedial action has been in terms of reduced accidents.

Let us consider a commonly accepted definition of a road accident, namely:

> ***"a rare, random, multi-factor event which is always preceded by a situation in which one or more road users have failed to cope with their environment."***

Accidents are rare events in terms of the passage of time and the numbers of traffic movements at a particular place on the road network. But in total, of course, they add up to an increasingly worrying problem which governments need to be aware of in trying to ensure the safety and mobility of its population.

They are random events in terms of one never really being able to predict exactly when one will occur. However, if they were completely random then it is unlikely that anything could be done to prevent them save for banning all traffic. However, research has shown that accidents tend to cluster at particular points of the network or among particular groups of road users, implying that there is often likely to be a non-random component in the occurrence of an accident.

In virtually all cases accidents are found to be multi-factor, e.g. rain, darkness, only 1 headlamp working, partially obscured visibility, driver having had a glass of wine, talking to a passenger, may all be factors in one accident in which a driver failed to cope with the situation - in that he failed to see another driver approaching a junction.

Although the causes of accidents are *multi-factoral*, there are likely to be common reasons for the clustering, ie. why different levels of risk exist (eg. due to poor road geometry, lack of/deterioration in skills of road user group etc.). Hence there should be potential for treating and even removing some of these problems and it is likely that if one of the factors is removed, then the accident event may not have actually occurred.

The targeting of road user groups, locations, routes or areas on the network for special remedial action (ie. blackspot treatment) has been proven to be very effective. For example, many low-cost accident countermeasures like chevron boards on bends have proved to be extremely cost beneficial: the value of accidents saved in just the first year being several times the cost of the scheme's installation.

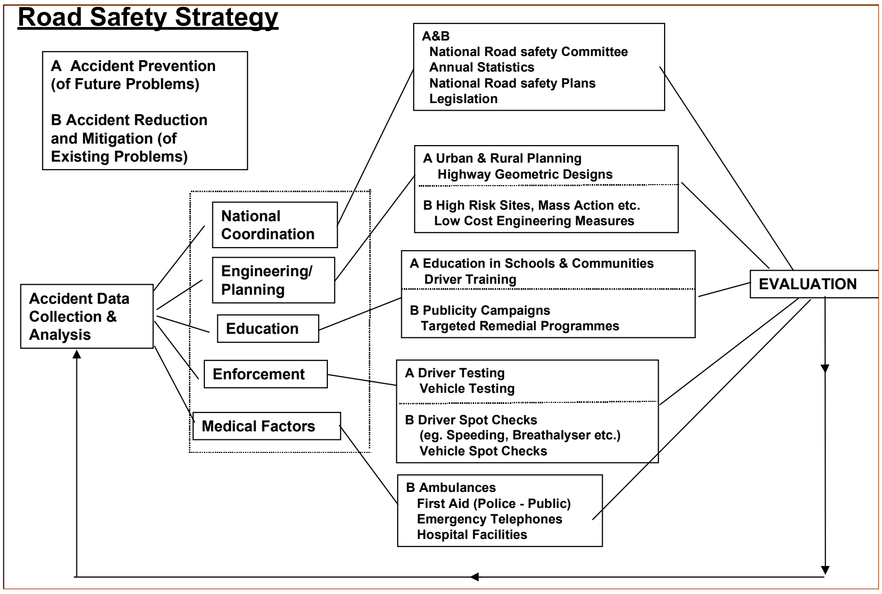


Figure 8

Figure 8 illustrates the two ways in which road safety is normally improved by various responsible bodies; ie. by either *accident prevention* {ensuring that road standards are adhered to, drivers are trained adequately, etc} or *accident reduction* {tackling problems on the existing network, vehicle/driver spot checks, emergency services etc}. It also illustrates the fact that the accident database should be at the heart of planning for improvement in all these sectors and should be used ultimately as the fundamental measure in evaluating how effective the various actions that are taken have been.

4 Establishment of a Traffic Accident Database

The accident database can be used at three different levels. At the macro or ***national*** level it can be used to help central government decide on safety policy (e.g. compulsory seat belt wearing or motorcycle helmet wearing). At a ***regional*** level it can be researched to help regional authorities make appropriate decisions (e.g. on local police campaigns on drink-driving, child safety education). Where the computerised database was originally envisaged to be of most benefit is at the ***local*** level where the database can be used by local engineers to determine where the main problems are on the network they are responsible for and, indeed, can be used in the blackspot process mentioned above.

However, it should be remembered that it is not only engineers that need to use an accident database. There are several different groups of people with road safety interests who require accident data. These include the police themselves, road safety officers and highway engineers, lawyers, research groups, politicians, teachers, statisticians, insurance companies and members of the public.

They all tend to have slightly differing needs and reasons for wanting the data. Whether it is statisticians investigating particular trends in accidents, insurance companies using data to set appropriate premiums, or even members of the general public needing access to their police accident report for insurance purposes, the common aim is, as stated earlier, 'to acquire as much relevant knowledge as possible from the data to help prevent accidents of similar nature from occurring in the future'.

Initially mainframe computers, but nowadays, microcomputers have now become the ideal tool for storing, maintaining and analysing an accident database. They are robust, relatively cheap, and have become extremely powerful.

There are four basic elements or processes to the way in which an accident database is assembled and utilised and these are:-

1. Accident reporting system
2 Accident recording system
3. Analysis of accidents
4. Dissemination of data

Most countries have found that there is a need for there to be a legal requirement for road accidents (or particular severalties of accidents, e.g. involving personal injury) to be reported to the Police, and it is advisable that this is reinforced by insurance company rules requiring claimants to follow this law. The best source of validated accident data will, therefore, be the Police force: either the policemen attending the scene of an accident or when reported to an officer at a police station by the involved parties/witnesses.

4.1 Under-reporting

It must be noted that there will inevitably be a substantial number of road accidents that are not reported to the police at all and the level of this under-reporting varies considerably from country to country. Even where there is a legal requirement to report only those accidents involving personal injury, studies of hospital data have demonstrated considerable under-reporting, though the level tends to be lower for the higher severities of injury.

ACCIDENT UNDER-REPORTING

Results from recent surveys

City	*Numbers of casualties* Hospital	Police	Matched with hospital	*Estimated percentage of total casuaties recorded by police*
Bangalore	**3045**	**1455**	**736**	**24% - 48%**
Hanoi	**2584**	**849**	**431**	**17% - 29%**
Dhaka	**890**	**68**	**31**	**3% - 8%**
Harare	**1077**	**1591**	**615**	**57% - 100%**

Figure 9

Figure 9 gives the results from a recent comparison survey of road accident victims between hospital and police data. These are, however, probably a worst-case scenario since records could not be matched on victims' name but only on date of admission, age and sex (and there are likely to be errors introduced in age estimations). Also, some of the victims taken to hospital may not have been registered as road accident victims. However, they give cause for concern about the quality of data available in many developing countries.

For comparison, Figure 10 gives underreporting figures published in 1996 of road accident fatalities in China, where it was estimated that the police records only show about 60% of fatalities appearing in

ACCIDENT UNDER-REPORTING IN CHINA

Reported by Duan Liren (BRITE), 1996: -

Road Accident FATALITIES

Health Depts	Police recorded	%age recorded by Police
111,000	**66,362**	**59.8%**

But ratio of reported fatal to injuries (China) = 1: 2.2

(Malaysia)	**=**	**1: 8.4**
(Japan)	**=**	**1: 99.5**
(UK)	**=**	**1: 92.9**
(USA)	**=**	**1: 81.0**

Figure 10

the Health Department records. The situation for injuries is likely to be much worse when one considers the ratio of recorded fatalities to injuries. There were only about 2 injuries reported per fatality in China which is low compared with another Asian country like Malaysia, and extremely low when compared with Japan and other developed countries since these tend to record about 90 injured victims for every fatality.

4.2 Road Accident Data Sources

There are really only four sources of possible accident data and no source will be perfect. Although hospital data may be the most reliable on individual casualties it does not tend to give any information about the actual accident incident itself and will not include many minor injuries, deaths and, of course, damage only accidents. Insurance company data is rarely collated on a national scale or even within a region and may have rather biased reporting. Some insurance companies may also be unwilling to reveal all their data for fear of competition.

Acquiring data from local residents may be feasible at a limited number of sites but is unlikely to be particularly reliable or complete from individuals questioned. Hence the police data set is the one most heavily relied upon and most commonly used, though ideally checks should ideally be made on its completeness from other sources.

1. Historically the way in which a country's accident database tends to develop is originally with the police needing to record basic accident details for their own records and for use in court in the prosecution process.
2. A uniform accident report form or booklet is fairly quickly introduced from which the police can produce basic statistics, usually for their own administration purposes.
3. With parties such as engineers requesting information about blackspots, the need for an improved database system tends to be acknowledged and often a new report form designed.
4. With the improved system parties such as the National Road Safety Council, universities begin to use the data, a detailed annual accident report is published and disseminated, and highway authorities are better able to plan and carry out blackspot improvement programmes.
5 When the data system is working well it is relatively accurate with under-reporting kept in regular check. It is available to all and able to be cross -referenced with other database systems like those from hospital, crime or vehicle databases.

5 The Accident Report Form

For most purposes the database needs to be able to answer the following questions: -

QUESTIONS FOR DATABASE TO ANSWER

- **Where** accidents occur
- **When** accidents occur
- **Who** was involved
- **What** was result of collision
- **What** environmental conditions existed
- **Why** or how did collision occur

Figure 11

Unfortunately, this does not mean that only 6 items of data need to appear on an accident report form. For example, the question of 'who' was involved for analysis purposes needs to include much more than a person's name. First, there may be several people involved, and thus all their ages and sexes need to be recorded The vehicle types involved in the collision must be known, and for police purposes driver's contact addresses, date of birth, driver licence details, vehicle registration, ownership etc. all need recording.

Obviously, governments or road/police authorities have their own and often very different views on what information about each accident should be recorded. For this reason it is unlikely that a completely unified report form would ever be accepted internationally, and indeed it is even difficult to draw up a definitive list of factors that will be required in all cases. Figure 12 contains a suggested list of factors appearing on accident report forms in many countries of the world which have generally been found to be useful to satisfy most of the needs of the various interested bodies.

RECOMMENDED FACTORS FOR ACCIDENT DATABASE

General Details/Attendant Circumstances	***Road type***	***Environmental features***	***Precise location***
Police reference Year Month Date Time Region/State Police Station reference Severity Collision Type Number of vehicles involved Number of casualties Contributory factors code	Class of road/road number Carriageway type/no. of lanes Speed limit Junction type Road width Road shoulder width	Light condition Road lighting Road surface condition (dry, wet etc.) Road surface quality (potholed, rutted etc) Weather Junction control Geometry (curvature, incline) Hit & run Roadworks	Map reference X-coordinate Y-coordinate Node 1 } *optional* Node 2 } Kilometre post To nearest 100m (eg. A8" = 0.8km) Plain language Location description (free text – abbreviated) Accident description (free text abbreviated)

Vehicle/Driver Details	
Vehicle type Vehicle manoeuvre Vehicle damage Length of skid marks	Driver age Driver sex Licence no. Seat belt/helmet Alcohol/drugs suspected

Casualty details	
Type of road user Age Sex Severity of injury Passenger location	Pedestrian location Pedestrian movement Passenger location School pupil

Figure 12

They can usually be divided into three main sections: General details, Vehicle (+ Driver) details, and Casualty details. As the relationship between these three areas can be one to many, accident data tend to be stored as a relational database. This is one of the reasons why an accident database is not straightforward and general-use commercial database packages can only be used with considerable adaptation, particularly in the way the statistics are analysed.

Note that, although most of the variables or fields can be coded or have straightforward values, there are two important and useful fields, which are usually free text format. These are (i) a description of the location (i.e. where the collision occurred), and (ii) a description of what actually happened in the accident.

Three important components which certainly need to be included in an accident report form are listed in Figure 13 below, and these tend to be features that are, unfortunately, often neglected.

SOME IMPORTANT COMPONENTS OF AN ACCIDENT RECORD

Unique accident reference:	Police station incident no. Year Police station identifier - (+ State and Region)
Sketches:	Collision Location
Accident location coding:	X-Y coordinates Kilometre posts Node-Link-Cell Plain language description

Figure 13

Each accident must have its own unique reference number to avoid duplication and to aid quick reference. In order that individual databases from different regions in a country can be easily combined to provide a comprehensive national database, this reference number can be a combination of a number of different fields like the serial number of the incident given by the police station at which it was reported; the year (assuming records begin again at the start of each year); and the individual police station identifier (which may be a combination of State or Region and probably District codes).

It is important that sketches are made of the accident site indicating how the collision took place, and policemen are used to drawing such sketches, as the courts often require them. However, it is also recommended that a separate location sketch be made using a simple road map drawing with the collision point clearly marked. This is so that anyone reading or coding the form other than the reporting officer and be sure of exactly where the accident occurred.

For computerised databases to be capable of being utilised for meaningful analysis, it is essential that the location of the accident is coded in some way. There are various methods of doing this (see following Section).

Ideally, the information required for each accident should be completed at the scene on an easy-to-complete form or booklet. It is also recommended that, if possible, a single form be designed for all purposes (i.e. used for court procedures, filing and computer data entry) obviating the need to transcribe data onto, for example, a computer coding sheet. Otherwise this becomes a separate task and one in which errors could be introduced. The form or booklet will also need to provide space (or forms for attachments) for driver, pedestrian and witness statements, written summary of the accident, and sketches.

It is considered important that the form is simple to complete and attractive to the eye to help prevent the task of form filling being regarded as too onerous by the police. All coding should ideally be contained on the form itself with the reporting officer simply having to encircle the value of the relevant code for each field. As mentioned there are, of course, fields in which text has to be written but these should be kept to a minimum.

A disadvantage of a booklet format is that more than one copy of the record is normally required and this can be a problem where photocopying is difficult. Some forces have attempted to condense the information to two A4 sides including space on the front of the form for the 2 required sketches.

5.1 Location Coding

It is very important that the location of the accident is recorded accurately, and a general map-type sketch as shown in Figure 14 (as well as the sketch of the actual scene) is also particularly helpful for others to know precisely the spot. From this they will be able to locate the accident location on a map and, ideally, will have more than one reference point with which to do so. For use with GIS systems, national X-Y co-ordinates are normally required in order to be able to 'plot' accidents on a computerised map. However, unless GPS units are used at the location of each accident these are normally read off a paper map. Mistakes will inevitably be made in doing this and for this reason, it is recommended that a secondary location system(s) is also used.

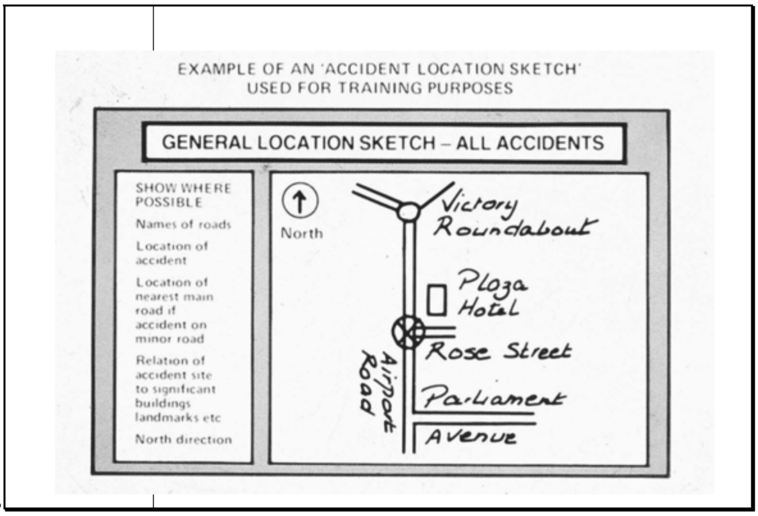


Figure 14

For rural highways it is strongly recommended that a system of kilometre posts is installed that have a clear unique reference number which the police can note. It is also helpful if strip maps are produced for the police accident reporter to use. These are simply all the local landmark descriptions linked schematically with the kilometre posts and nearest 100m points for easy reference so that the police can check accident location from their notes. Strip maps are well worth the effort required in producing them.

Node map example: Zimbabwe

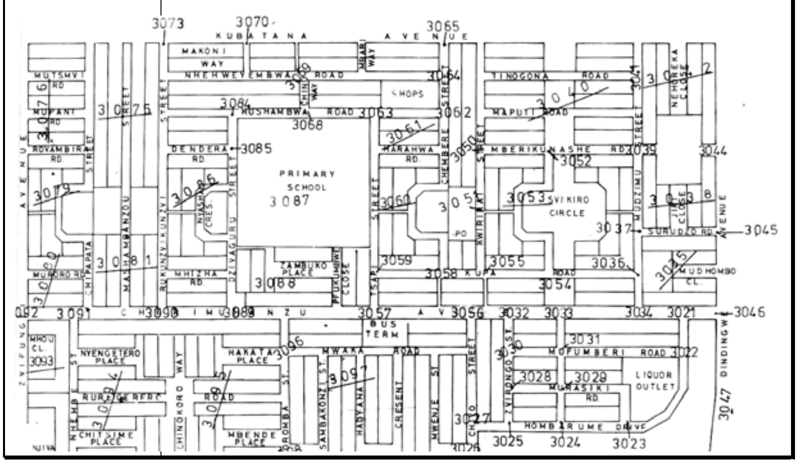


Figure 15

Kilometre posts are, of course, not practical in the towns and cities where perhaps even more precise location coding is necessary. Some police or city authorities have produced a node-link-cell system (eg. see Figure 15) where each junction or section of road is given a unique node number. Accident locations on links or stretches of road can simply be defined by the nearest node number on each side. In the above example the numbers are a mixture of nodes (individual junctions) and links and even cells (numbers given to an area of perhaps minor housing estate roads).

EXAMPLE OF ROAD SECTIONING

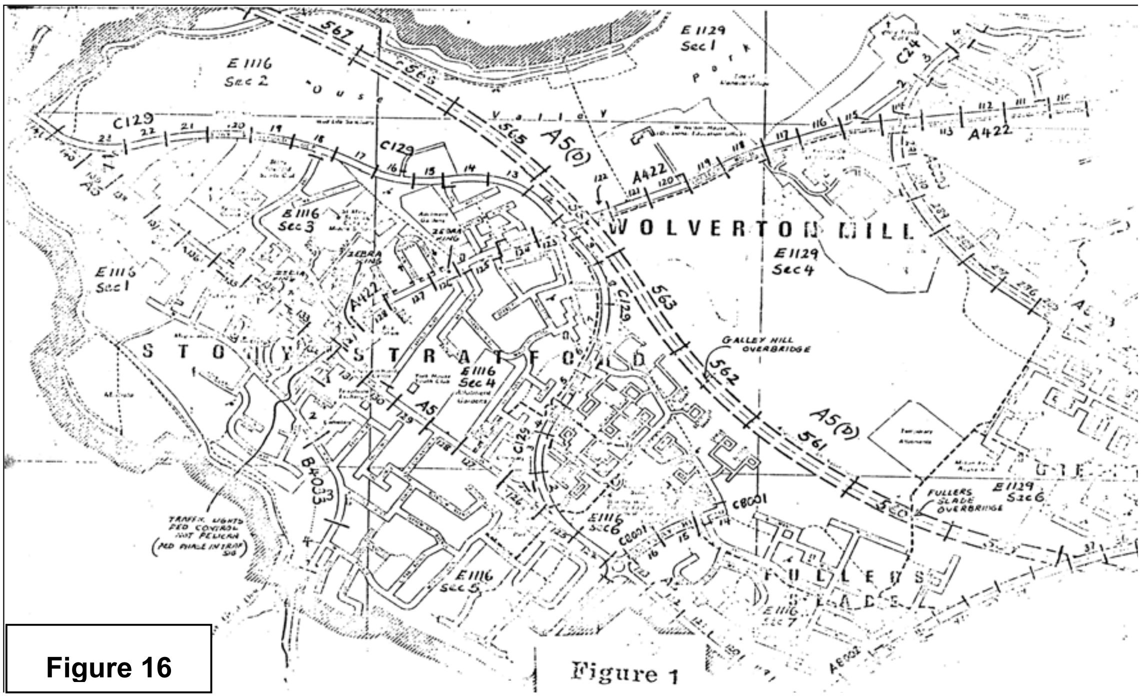


Figure 16

Figure 16 is an example of another system called BOBSTAR used in Berkshire, Oxfordshire and Buckinghamshire in the UK where the authorities have divided the network up in to labelled sections (of 100m length on minor roads and 250m on major roads)

6 Examples of accident data software analysis systems

The road authority in the previous example can periodically query their complete BOBSTAR database to determine “norms” or average numbers of particular accident types for the network as shown. These are then the reaction levels used as a gauge by the engineer to look at sites which exceed these numbers of accidents (some are illustrated in Figure 17). Note that sometimes several sections may need to be considered together (e.g. 2 or even up to 5 {for ice})

EXAMPLE OF ‘REACTION LEVELS’

Berks./Bucks./Oxfordshire

Accident Analysis	*Run for*	*Normal County %*	*Number of sections analysed*	*Criteria use*	*% of all accidents*	*Code*	*BOBStar Run no.*
All accidents	County		1	8 in 3 years 6 in 2 years 4 in 1 year		A36m A24m A12m	01
	County		1	10 in 3 years 8 in 2 years 5 in 1 year	-	A36m (2$) A24m (2$) A12m (2$)	02
	County		1	14 in 3 years 11 in 2 years 8 in 1 year	-	A36m (3$) A24m (3$) A12m (3$)	03
Note: “ + “ after A12m criteria shows an increase in accidents over the last year compared to the average of the previous two years							
Accidents in dark	County	28	2	3 in 3 years	50	Dark	12
Accidents in dark and on wet road	County	12	2	3 in 3 years	25	Dk + Wt	12
Accidents on wet road	County	32	2	2 in 1 year	60	Wet	22
Accidents on wet road And with skidding	County	17	2	2 in 1 year	30	Wt + Sk	22
Ice with skid accidents	County		5	3 in 6 years	-	Ice	35
Slippery road (not weather)	County		1	2 in 1 year	-	Slip	41

Figure 17

Figure 18 is an example output from KeySystems, which is more of a drawing-based system rather than database management. As can be seen, it can produce quite sophisticated drawings and labelling of individual sites (as long as this type of drawing is stored digitally) together with a stick diagram and simple bar charts.

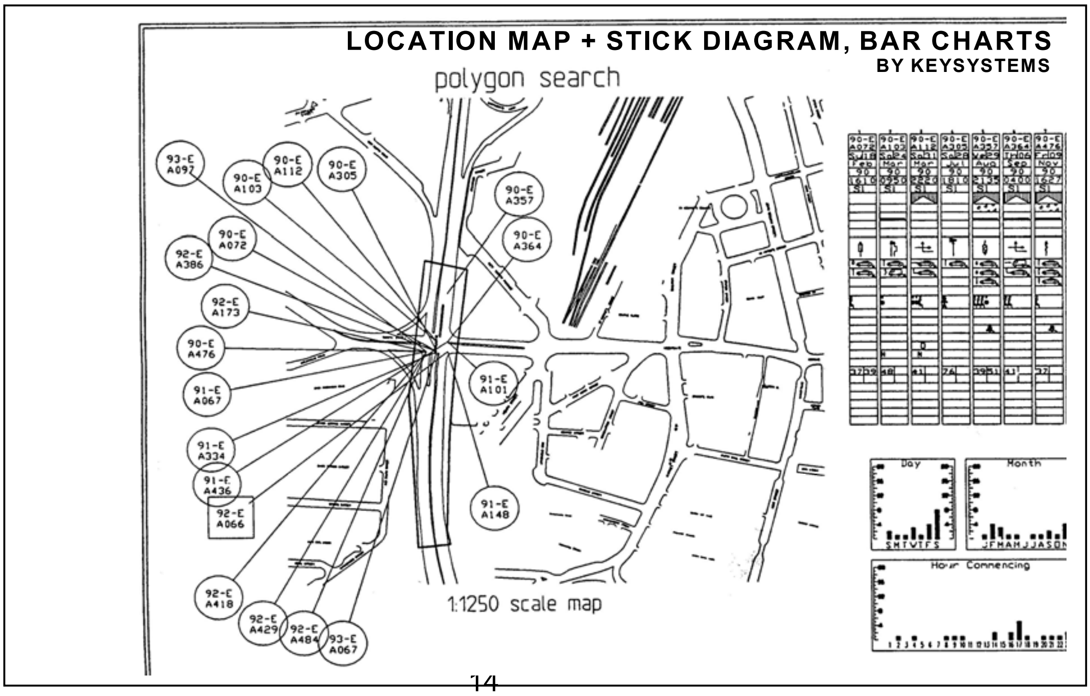


Figure 18

Figure 19 gives a sample printout from HSS, an American software package, which can produce collision diagrams. However note that all collision types with the same movements have been grouped together. The location of the collision types is therefore symbolic, and not the actual location within the junction. However, the location of the group can be moved en bloc.

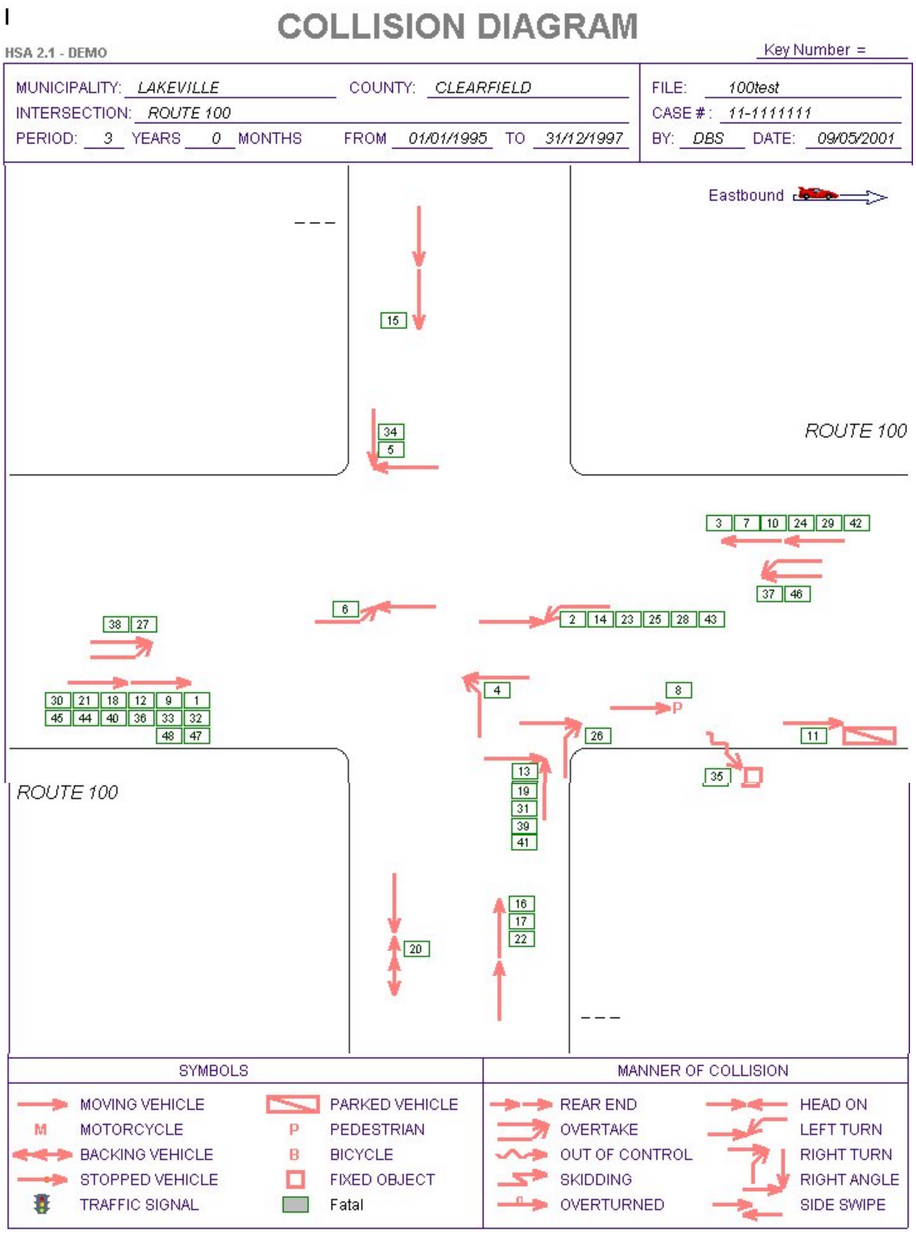


Figure 19

These kinds of drawings and graphics are particularly useful when the engineer is drafting up a report on a site to make the case for his proposed remedial action.

6.1 TRL Microcomputer Accident Analysis Package, MAAP

TRL's MAAP package arose from need when safety specialists visiting developing countries during the 1970's often found that accident data were very poor and not computerised. Even if data were computerised it was usually stored on a mainframe computer which only experts could use, and specific queries would actually take many weeks to be processed.

Microcomputers were fast developing and becoming more powerful. They were robust and together with user-friendly software that tended to be written for them, meant that users needed little or no training in computing. They were thus seen as the ideal tool for database management and analyses in the Third World. TRL began a project with the Egyptian Govt in 1981 initially to study safety on the arterial roads out from Cairo.

The Egyptian Police knew that there were many accidents along these roads but were unsure about the actual number of accidents and their precise locations and types. Much effort was initially spent in developing a suitable and easy-to-complete accident report form (resulting eventually in the blue booklet already shown – example page in Fig. 14). The software was then written to be as general as possible so that during much of the 1980's the system could be adapted for use in other countries.

In 1991 TRL produced a fairly major upgrade of the DOS version of MAAP with pull-down menus and the inclusion of graphics capabilities, making it look much more like 1990's software, and in 1998 TRL produced a Windows version with many new important features. Some of these are illustrated below.

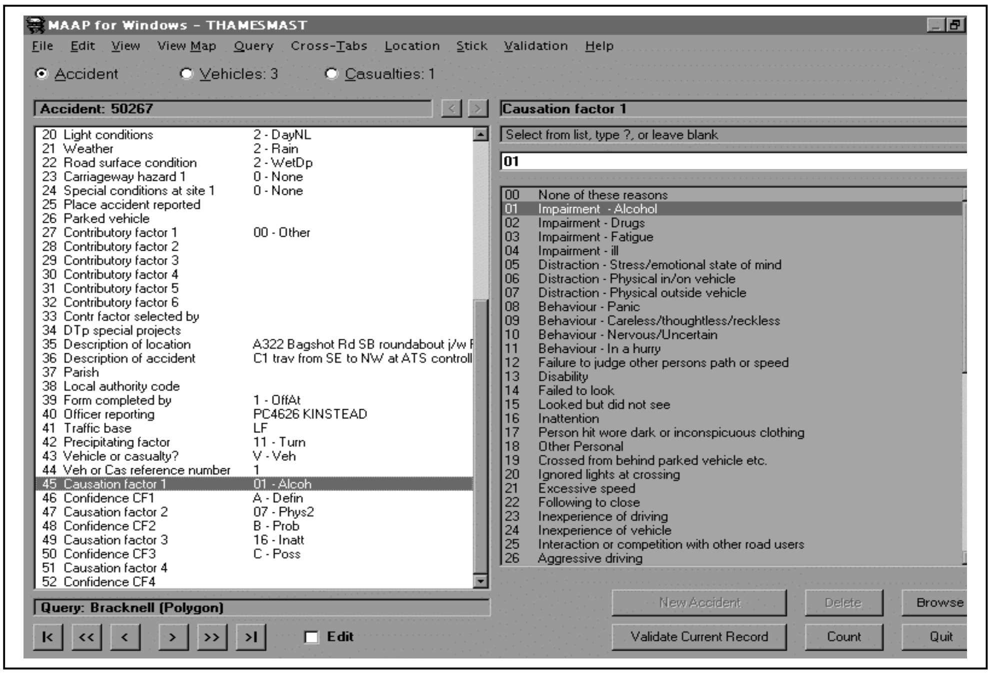


Figure 20

Figure 20 shows the way in which data is displayed by field names (on left-hand side) and their valid codings with explanations appear on the right-hand side. The user can scroll around the database or locate individual records or sub-sets of data (eg. accidents involving a cyclist) using simple query logic.

It is possible to produce simple or complex multi-dimensional cross tabulations as illustrated in Figure 21 which shows casualty class (driver, passenger or pedestrian) by sex by age group and by day of week.

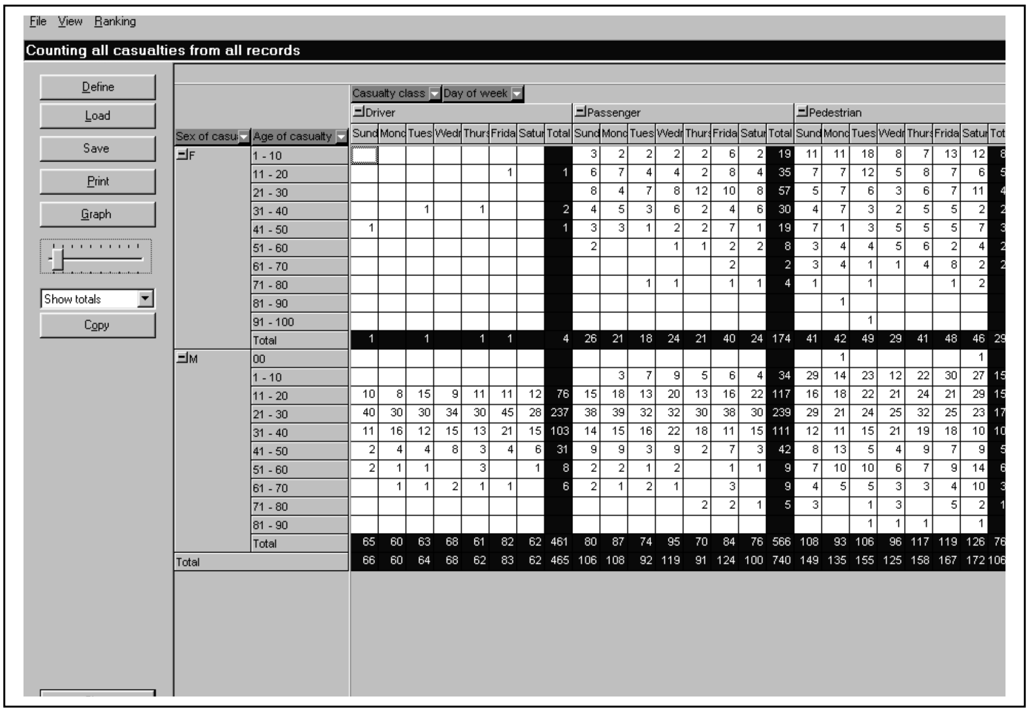
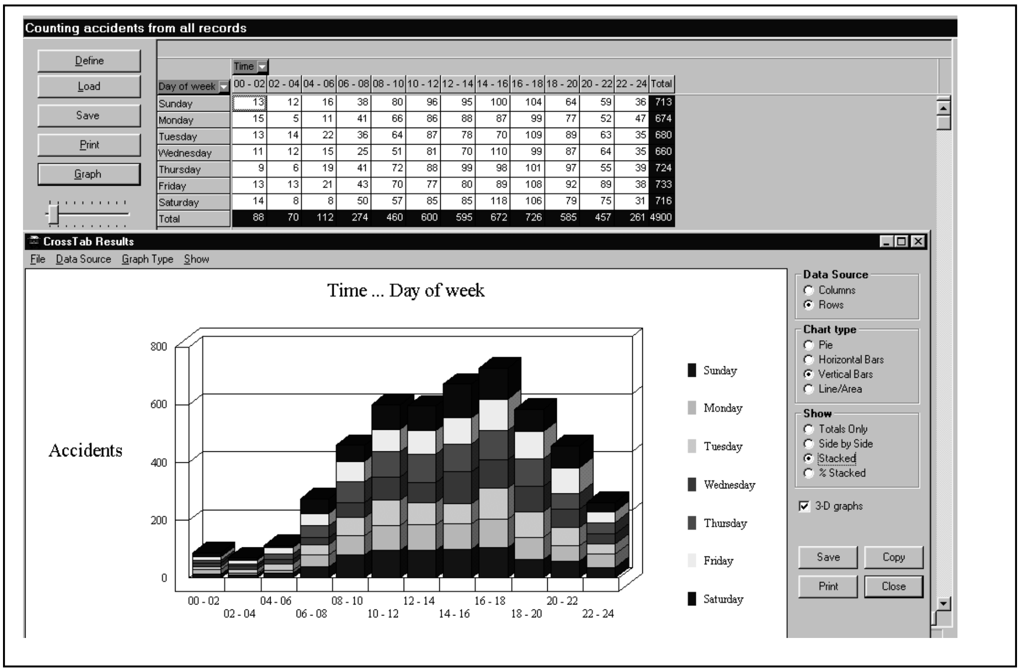


Figure 21

Cross tabulation data can be easily displayed graphically as illustrated in the bar chart of Figure 22, or can be 'pasted' into other commercial general spreadsheet packages for further analysis.



Day of week	00 - 02	02 - 04	04 - 06	06 - 08	08 - 10	10 - 12	12 - 14	14 - 16	16 - 18	18 - 20	20 - 22	22 - 24	Total
Sunday	13	12	16	38	80	96	95	100	104	64	59	36	713
Monday	15	5	11	41	66	86	88	87	99	77	52	47	674
Tuesday	13	14	22	36	64	87	78	70	109	89	63	35	680
Wednesday	11	12	15	25	51	81	70	110	99	87	64	35	660
Thursday	9	6	19	41	72	88	99	98	101	97	55	39	724
Friday	13	13	21	43	70	77	80	89	108	92	89	38	733
Saturday	14	8	8	50	57	85	85	118	106	79	75	31	716
Total	88	70	112	274	460	600	595	672	726	585	457	261	4900

Figure 22

The software can display accident plots on available digitised maps and can perform different types of cluster analysis as shown in Figures 23 and 24. Figure 23 shows a grid density analysis of a road network with the denser squares displayed in different colours so that the analyser is made aware of and can focus attention on these hotspots or blackspots. Different weightings can be applied to surrounding areas so that a realistic priority listing can be drawn up.

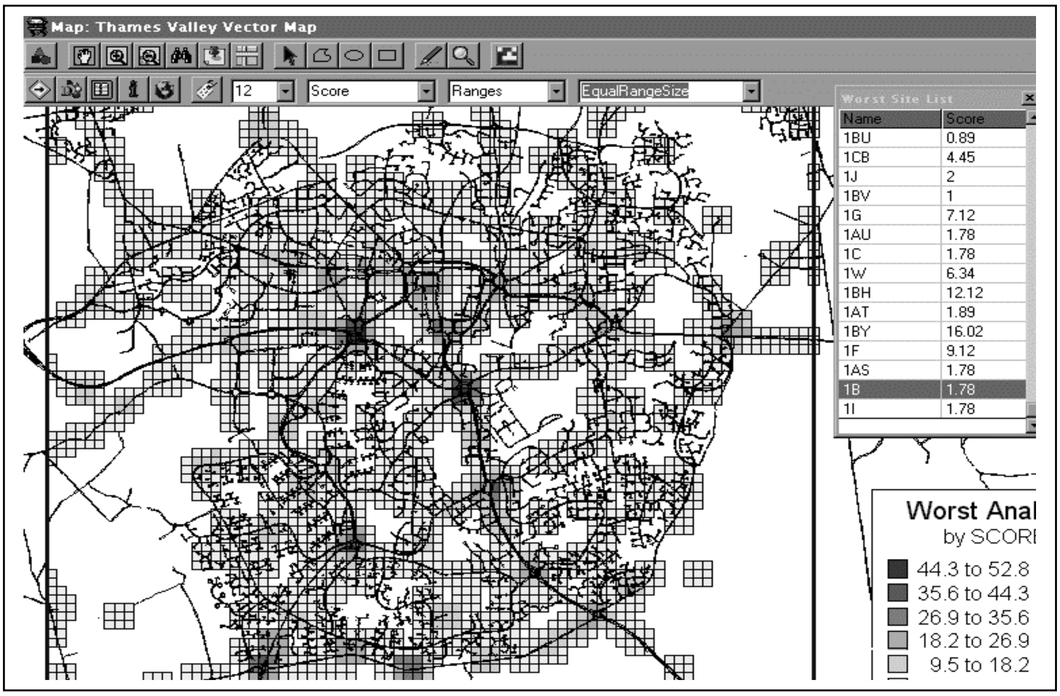


Figure 23

Figure 24 shows a different form of cluster analysis whereby the user can define related accidents as lying within a defined distance of each other.

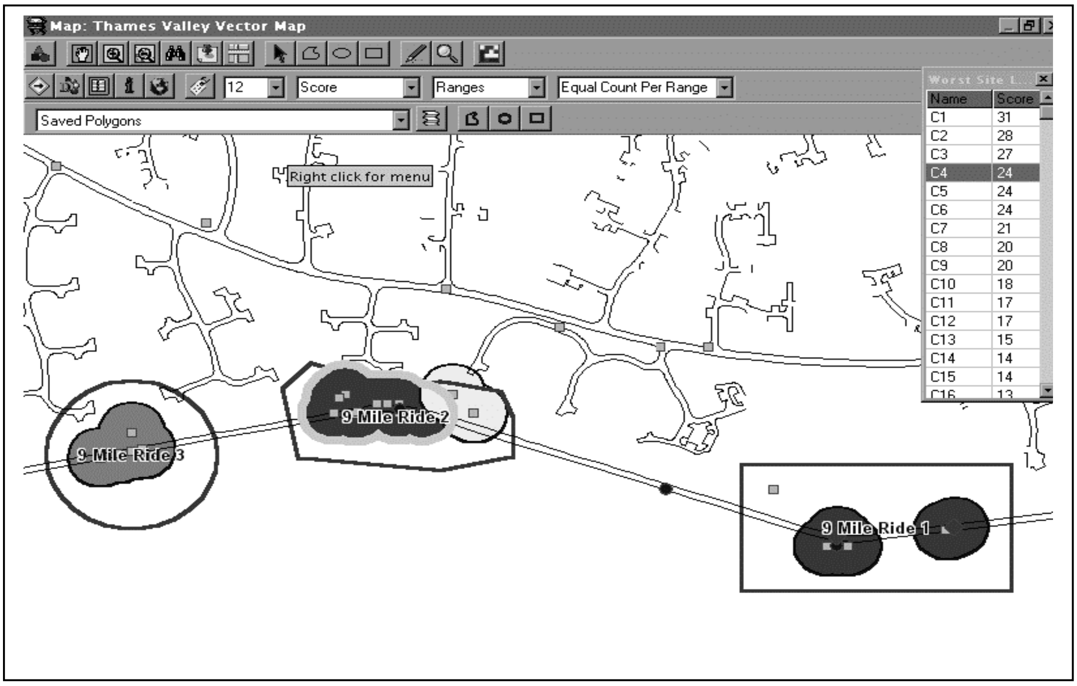


Figure 24

The blackspot areas as highlighted by this analysis can be saved as geographic polygons so that any future accident countermeasures at the sites can be evaluated at a later date (as shown in Figure 24).

The accidents 'captured 'within these areas can be analysed for common patterns to determine whether they are amenable to treatment.

As well as producing tabulations of these blackspots or reviewing all the records individually, MAAP offers the facility of producing 'stick' diagrams (as mentioned earlier) and shown in Figure 25, so that the user can search visibly for common features. The user is able to define

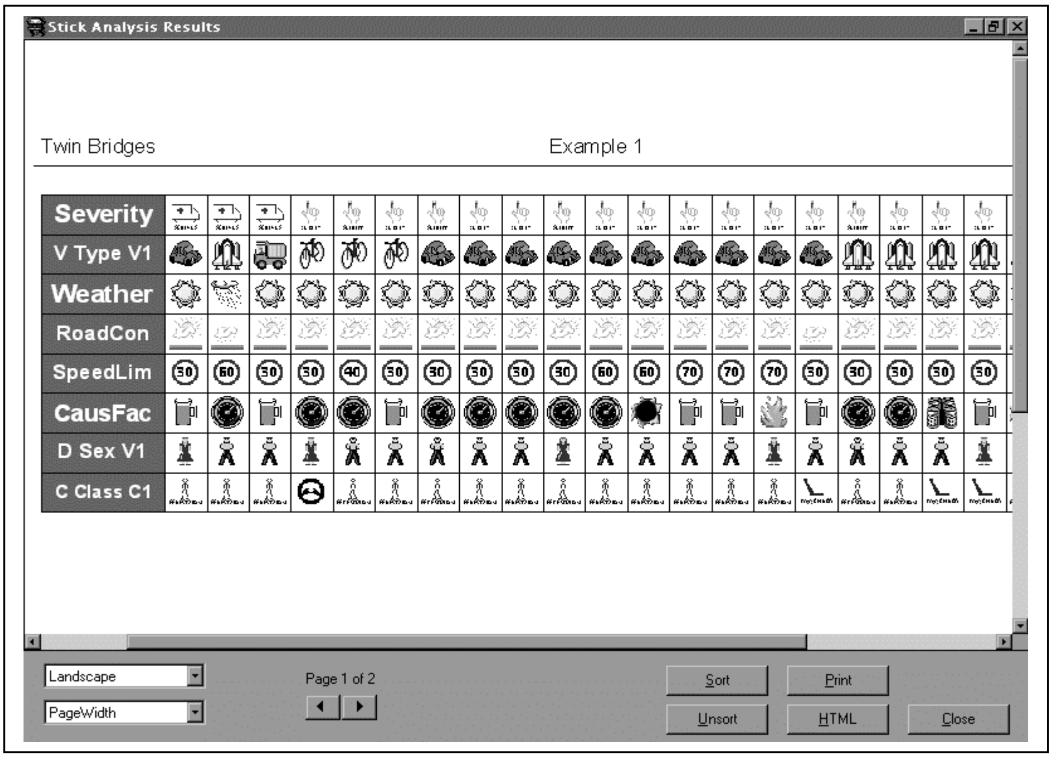


Figure 25

any data feature he chooses with any symbol, and can sort the 'capture' sticks into order by any feature or group of features.

MAAP for Windows systems are now in use in Belize, Estonia, Nepal, Jamaica, Turkey, Vietnam, Barbados, Jordan, Thailand, Colombia, Mauritius, Sri Lanka, Zimbabwe, Uganda and Fiji and has even been adopted by over 8 UK Police authorities.

7 Conclusions

This paper has attempted to give an overview of the main current road accident statistics of developing countries, and highlighted the fact that these countries generate a highly disproportionate amount (85%) of the world's fatalities. The situation also tends to be worsening as these countries' vehicle fleets are growing rapidly, and efforts to improve safety are not keeping pace. However, methods applied in many of the developed countries have demonstrated that it is possible to slow or arrest this growth in accidents. To achieve this requires dedicated safety workers to carry out regular, in-depth analyses of patterns of accidents and to then target many of these with various (low-cost) remedial actions that are likely to yield the most effective results

For this, the establishment of a reliable road accident database and analysis system is of paramount importance, and this must be made accessible to all those bodies able to contribute to accident reduction (like the Police, highway engineers, vehicle engineers, education services, etc). Indeed, it is likely that an unreliable or inaccessible database will only lead to inefficient management of road safety. The paper has discussed the more important elements of such a system and illustrated these with selected examples from systems in use.

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