Analysis of target area tables is a subjective procedure supported by a general knowledge of traffic safety programs. The main factors used to identify apparent traffic safety problems are the percentage and the frequency of accidents in each cell.

The traffic accident file constitutes an exceptionally rich source of information. It should not be overlooked as a resource for multiple purposes: policy analysis, resource allocation, problem identification, and countermeasure design.

STATE-OF-THE-ART TECHNIQUES FOR COST-EFFECTIVE SOLUTIONS

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The U.S. General Accounting Office has suggested that the Highway Safety Program has achieved only limited success in reducing the number and severity of accidents. The problems impeding the development of effective safety programs have been identified for many years. Some of the major problems are as follows:

- The direct measures of safety—accident reports—are incomplete, inaccurately reported and coded, and biased. They also fluctuate widely from year to year at a location. Thus, it is difficult to use accident records to accurately identify safety goals and problems.
- Few administrative and effectiveness evaluations of safety projects have been conducted by using sound analytical techniques. In most cases, the impacts of projects on safety have not been determined.
- Accident records systems are generally not designed for safety analysis.
- There is considerable duplication of accident records and safety-related data, and much of the available data is not used for safety purposes.
- Research results obtained from studies conducted by federal and state agencies, universities, and other agencies are not used effectively to improve safety programs.
- Many safety administrators believe that every dollar spent on safety is worthwhile.
- Many agencies do not have personnel adequately trained to conduct safety analyses.
- Effectiveness and economic analyses are often conducted to justify the selection of safety projects rather than to determine whether projects are justifiable.

Every state has made progress implementing safety programs during the past 80 years; achieving further significant reductions in accidents and their severity during the next several decades may be impossible. A more realistic goal may be to maintain the current accident rate or number of accidents per 100 000 population (or registered vehicles). This pessimistic view is, in part, supported by the following observations:

1. The current impediments to achieving safety results cannot be overcome immediately. Even with pre-1981 safety funding levels, it would take 10 years or more to upgrade safety programs to the point where significant measurable results could be shown.
2. There are no major developments envisioned within the foreseeable future that will lead to improvements in highway safety. For example, no major highway construction program, such as the interstate system, is contemplated.
3. Safety budgets at the state and local level are likely to be reduced as funds are spent on more pressing issues such as maintaining essential services.

Given existing and future constraints, it is imperative that safety administrators improve the efficiency of their operations and the effectiveness of their safety projects and programs. Fortunately, the analytical techniques and technical equipment for achieving success are available. The challenge faced by safety administrators is to apply state-of-the-art methods to increase the probability of implementing cost-effective solutions. In many cases, the techniques are not labor intensive, nor do they require large capital investments for implementation.

While the level of effort is often a function of the size and safety responsibilities of an agency, a number of techniques are applicable for all agencies. Some of the most pertinent measures are described below.

PLANNING TECHNIQUES

Program administrators must establish an efficient procedure for using accident data to meet safety goals. In the planning phase, the administrator must have a data base capable of identifying specific safety problems and evaluating project impacts. The results of completed research and data bases such as National Accident Sampling System may fill the need.

While developing an integrated data base may be an ultimate goal of a safety agency, safety analyses should not be deferred until the base is completed. Local agencies can and should identify many important safety problems with existing data sources.

ANALYTICAL TECHNIQUES

Too often, little effort has been placed on using analytical techniques for safety analysis. For example, many safety effectiveness evaluations are currently being conducted simply as a comparison of the before-and-after accident frequencies. A number of user-oriented automated packages are available for more sophisticated analysis, but not all techniques require installation of complete packages. Simple manual procedures for conducting project and program evaluations have been developed by the Federal Highway Administration. The National Highway Institute will provide the manual and training course at no cost to the states.

PERSONNEL ISSUES

Safety analyses cannot be accomplished without properly trained personnel. Although desirable, it is not absolutely necessary that professional engineers make up the majority of the staff. It is essential, however, that the performance of the staff be measured. A measure of staff performance is provided by the answers to the following questions:

1. Do staff members have access to and use professional journals such as those published by the Transportation Research Board and Institute of Traffic Engineers to upgrade or improve their safety analysis?
2. Is the staff actively involved with other safety-related agencies and with the public?
3. When did the staff last attend a safety training course or seminar?
4. When did the staff last use a new or more efficient method to conduct safety analysis?

If the answers to the first two questions are no, immediate corrective administrative action is necessary. If the answers to questions 3 and 4 are "last week", the safety program is likely to be operating efficiently.

TECHNIQUES FOR COST/BENEFIT ANALYSIS

The ultimate goal of all safety projects is to reduce accidents in the most cost-effective manner. The use of the incremental cost/benefit ratio and of dynamic and integral programming is appropriate for selecting safety improvements that will optimize safety benefits for every dollar spent.

Dynamic programming is an optimization technique that transfers a multistage decision problem in a series of one-stage decision problems. It is used to allocate money to obtain the maximum possible benefits under a fixed-budget. The three possible levels of dynamic programming are:

1. Single-stage (used to evaluate a single project with several alternatives),
2. Multistage (involves selection among several projects with several alternatives each), and
3. Multistage with a time factor (used where several alternatives are considered and various time periods are involved).

Basic input into the dynamic programming model consists of (a) initial costs and maintenance costs for each project alternative, (b) accident benefits for each project alternative, and (c) budget available for improvements. Dynamic programming can take advantage of greater benefits by choosing a project that will yield greater benefits, even though it shows a lower cost/benefit ratio than another alternative. Therefore, expenditure for a group of projects chosen by dynamic programming can yield greater dollar benefits than expenditure for the same projects chosen through the cost/benefit technique. In some instances, the same projects will be selected. The optimal selection of projects is sometimes fairly obvious by using manual techniques; however, where many projects are involved, computer analysis must be used.

USING DATA ANALYSIS AND REPORTING TECHNIQUES (DART) FOR PROBLEM IDENTIFICATION

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The Data Analysis and Reporting Techniques (DART) system was developed by GENASYS Corporation under a series of NHTSA contracts. It is a computer software statistical system that was specifically designed to assist in the problem identification process for the acquisition, selection, and analysis of state accident data.

The objective of the DART system is to overcome the lack of integrated data that resulted from poor communication between state agencies. Historically, a state agency designed a traffic records system to meet its particular needs. Other agencies requiring the same information were rarely consulted. As a result, several components of the overall traffic records system were developed, and each was organized and operated differently. This presented a basic problem in the development of an integrated system.

DART was thus developed in an effort to deal with these partially integrated traffic records systems. While there was little doubt that a tool for analysis was needed immediately within the highway safety management program, it was unlikely that an integrated traffic records system would be a reality within the near future. DART was designed to address this problem; consequently, it allows for upgrading of the traffic records system as integration capability is achieved.

An initial decision was made to create a subsystem that would require information from all the other data subsystems. Thus, the safety analysis and reporting system required group analysis of accidents so that the problem identification process could be implemented. This emphasis on problem identification has placed the burden on states to develop better data, better records systems, and better data analysis capabilities. However, dependence on accident records systems has revealed the inadequacy of many state systems to support a coordinated problem identification process. The analytical techniques used by many states are merely elementary analyses—an indication of a potential problem.

The use of DART in the problem identification process is one way to improve a state's analytical capability. Problem identification is simply an iterative process of comparative analyses that narrows the potential problem populations until the true problem is identified. The effectiveness of countermeasures can be evaluated by performing the same analysis after a period of time has passed.

Analysis through use of the DART system must be performed on a static data file. At least one full year—ideally multiple years—of data is used to develop trends and to evaluate the impact of ongoing programs.

The first step is to produce a full file univariate that will show areas of high accident involvement. A full file univariate is a one-way frequency distribution of each data element present on the data file. The file also reduces each subset of all data elements to a relative percentage or weight in the overall population under analysis. High involvement does not necessarily mean that a problem has been identified; this step in the process is designed to lead the researcher on into comparative analysis.

The next step in our problem identification process is to isolate the potential problem groups highlighted on the univariate and to look at attributes that may contribute to their accidents. The researcher may decide to break the groups down further—for example, into males and females within specific counties. The selection process allows a comparison of county versus county, male versus female, etc., by any attribute selected and in any combination. The DART output of such a comparison of accidents would be a table showing these figures.

The frequency of accidents by each age group can then be compared, and any discrepancies can be determined. Each age group is reduced to a common denominator, that is, to its relative weight percentage within the population. By using this common denominator as the basis for comparison, it can be surmised that potential problems rest within different age groups by sex. The DART report would be (a) a table showing both accident frequencies for males and females in each age group and the percentages representing those frequencies, and (b) a graph comparing the percentages. The comparison highlights overrepresentation in various age groups.

The process has thus far succeeded in illustrating vast differences between males and females by age group. In order to establish what can be expected, these facts must now be compared with normalizing data. Normalizing data are external factors used to determine the appropriate weight to be given to the accident figures for each sex and age group. If further analysis is to be based on exposure, one criterion that may establish exposure to accidents would be the number of licensed male and female drivers. The computer would be asked to supply a report on the number of licensed drivers by sex and age.

In the next step, the number of licensed drivers by sex and age is reduced to a weight (percentage) within the population 16 to 30 years of age. The percentage of accidents involving males can then be compared against that of male licensed drivers, and the percentage of accidents involving females against that of female licensed drivers. The DART graphs showing these comparisons would indicate the extent of overrepresentation in particular age groups with respect to exposure.