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Route safety management and evaluation guidance

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Transport Research Laboratory

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Route safety management and evaluation guidance

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Abstract

Road safety has often been improved by treating specific sites at which there have been accident clusters. Subsequently, accidents are now more likely to be scattered along a route and less focussed on specific locations.

'Route safety' is the treating of a route as a whole. This can offer drivers travelling along a route consistency, such that they can know the behaviour expected of them. It may reduce the problems associated with 'regression to the mean' since sites at which there is an 'accident waiting to happen' may be treated before this occurs.

Route identification should involve consideration of the accident rate on various similar routes over several years. Analysis of previous accidents is key to selecting the package of interventions. Route safety is not restricted to the prevention of accidents; it also allows for some measures intended to reduce the severity of accidents.

This guidance recommends that a route safety approach includes:

- The use of accident rates and thresholds to determine the most risky routes, benchmarking routes against one another
- Evaluation of accident numbers and types over several years
- Linking of safety performance to highway environment
- Consideration of the collision history, e.g. weather, time of day, road surface condition and other contributory factors. exploring more fully the factors contributing to the accidents concerned
- Measurement of proxies such as speed
- Information targeted at specific types of driver and driver behaviour
- Monitoring regimes
- Use of recognised standards on improvement schemes
- Counter-measure evaluation

1 Route Safety

Route safety management refers to the treatment of accidents that are distributed along routes rather than clustered at specific locations; the focus is naturally on routes consisting of lower quality roads, and thus they tend to be local authority roads rather than roads managed by the Highways Agency. The County Surveyors Society (CSS) funded Route Safety Research which has informed this guidance.

1.1 Definition of a route

It is useful to consider what is to be regarded as a 'route' within the context of route safety. Route safety is intended to be focussed on the treatment of scattered accidents on routes consisting mainly of lower quality roads. In this context a route can be defined as consisting of roads with broad consistency in terms of usage, traffic flow and other characteristics.

Most routes will be at least several if not many kilometres long and are likely to carry a good deal of through traffic along the route. However, there will also be routes that are shorter particularly on urban and semi-urban roads, some of which may have sections with mixed priority. Routes may contain major as well as minor junctions.

Most routes will consist of single carriageway rural roads because of the emphasis on lower quality roads and on length. There is already some guidance for route treatments on rural roads (TRL, 2004) and on Highways Agency routes (Highways Agency, TRL, Scott Wilson, 2003: Highways Agency, 2002), which has been used to inform this guidance.

Route safety treatments are not intended to address safety issues on short sections of road around schools or in town centres or the particular circumstances of mixed priority routes. Guidance on treatments for the latter has recently been published (Department for Transport, 2008).

1.2 Route safety treatments

A 'route safety treatment' consists of a package of interventions to reduce accident risk and severity along a route.

The aim is to treat accidents that are distributed along a route rather than clustered at a specific location. This does not necessarily exclude site specific interventions should large clusters of accidents exist on a route, but aims to 'learn the lessons' of a particular accident problem that occurs along a route at similar locations where such accidents are yet to occur.

The emphasis is on a consistent approach to treatment so that drivers are not caught unawares by unexpected changes to the road environment along the route.

In part because of the requirement to treat whole routes, the treatments will tend to be low cost interventions. A treatment may involve any of the three 'E's (engineering, enforcement and education) or a combination of them.

The future direction of route safety will be to emphasise the relationship between driver behaviour and the environment along the route, with the environment being designed so as to encourage the driver to choose the most appropriate behaviour for the section of the route in question.

2 Current route safety management and evaluation

2.1 CSS Route Safety Research

The guidance is in part based on the findings of recent research on route safety sponsored by the County Surveyors Society and conducted by TRL (formerly the Transport Research Laboratory).

Route safety methodologies and scheme evaluations were obtained from several local authorities through the County Surveyors Society. The information sought included:

- numbers of accidents and casualties at each severity level (fatal, serious and slight);
- traffic speeds before and after implementation;
- effects of driver and rider behaviour
- traffic flows before and after scheme implementation in order to obtain accident rates and to assess any changes in exposure;
- local community feedback on the scheme;
- costs; and,
- other benefits.

2.2 Research findings

The responses varied to some extent between the various local authorities but suggested some elements of good practice. Some, but not all:

- adopted a systematic approach to identifying the factors associated with accidents and in the selection of suitable treatment;
- plotted accidents on maps to identify the locations of accidents clusters and of accidents that were distributed along the route;
- set accident thresholds in order to identify problem routes;
- prioritised the routes according to the severity of the accident problems, the availability and selection of suitable treatment, the likelihood that the treatment would be successful and the cost of the treatment;
- monitored the route after treatment to determine its effectiveness.

Before and after evaluations as indicated in the above were mainly based on accident numbers but sometimes speeds were also considered.

The local authorities reported casualty reductions typically between 30 per cent and 70 per cent for routes which were of sufficient length to produce a meaningful number of accidents in the before period. Occasionally, there were no accidents in the after period. This may have been attributable to a significant effect caused by the treatment, but since these cases tended to apply to routes where the numbers of accidents were relatively small in the before period, it is possible that the reductions would have occurred without any treatment.

Some of the reductions may be attributable to a particular type of selection bias, sometimes known as the 'regression towards the mean effect', rather than to the treatment. If routes are selected on the basis of their past accident history, some of the routes may have relatively high accident numbers not because they are intrinsically unsafe but simply by chance. In the after period it is likely that their accident numbers will return to normal. This is often interpreted incorrectly as a reduction attributable to

the treatment, whereas the some of the reduction would have occurred without the treatment.

An example of successful route treatment on local authority roads is the B4012 south of Thame in Oxfordshire. The treatment included the use of double white lines to reduce overtaking, warning signs in advance of tight bends and illuminated road studs. There were 32 accidents in the five year period before treatment but only 16 accidents in the five years after treatment. The severity of the accidents was also reduced.

A further example is average speed cameras, as monitored by the National Safety Camera Programme; these have produced reductions in accidents and associated casualties, by modifying driver behaviour and in particular reducing excessive speeding.

3 Understanding why accidents happen

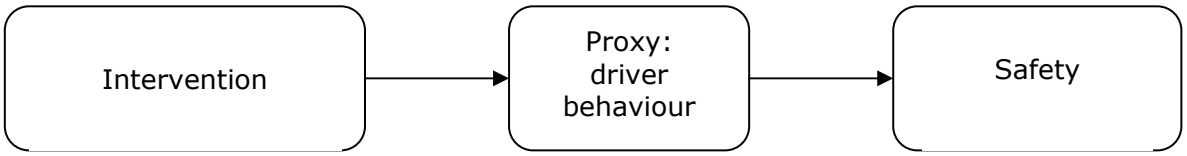
An understanding of how driver behaviour is to be influenced by a treatment is of importance, and measurement of driver behaviour should be used in assessing the success of treatment.

Several years' accident data is normally needed to determine, in accident and casualty terms, whether the treatment has been successful. This is rather a long time to wait. It is therefore helpful to measure driver behaviours as proxies for safety.

Understanding what drivers are doing helps to explain why particular accident types occur; if occurrences of particular driver behaviours reduce following a treatment, it is likely that the treatment can be credited with the reduction in the frequency of the unsafe behaviour in question.

If there is a particular problem with head-on accidents on a route, for example, it may be informative to consider the level of overtaking. If the level of overtaking on the road in question is higher than that on other similar roads which have lower head-on accident rates, the treatment may seek to reduce overtaking in order to improve the route's safety. Measurement of the overtaking rate in the 'before' period would thus help inform the treatment selection, and it is clearly then desirable to measure the overtaking rate 'after' the treatment to monitor its effectiveness.

The aim, therefore, is to select a package of interventions which reduce the frequency of occurrences of the driver behaviour identified as undesirable, which acts as a proxy for safety:



A further example, in relation to accidents on bends where the selected treatment may involve re-marking the carriageway with the intention of reducing speed in advance of and through the bend; it would be desirable to monitor speed profiles and lateral positions of vehicles before and after the treatment, in order to confirm that drivers have reduced their speeds and changed their lateral positions as was intended.

Driver behaviour generates many more data than accident numbers or rates and therefore is less susceptible to statistical variation. For example, if the treatment is intended to reduce mean speed or overtaking rate, then if these are reduced after treatment it may be reasonable to conclude that the treatment was successful (and this strengthens the case for claiming that any reduction in accident numbers or rates is attributable to the treatment).

These 'behavioural measures' also provide feedback far more quickly and remove the statistical difficulties associated with issues such as regression to the mean. Monitoring of this nature is normally relatively cheap to carry out (within the context of the budget for the treatment).

4 Route safety guidance

4.1 The process of management and evaluation

There are three main stages in the process:

- collect and analyse data;
- choose the package of interventions
- monitor and evaluate performance.

Although these stages will be normally conducted in the above order, it may be necessary to return to the previous stage or stages if the results from the final stage are unsatisfactory.

4.2 Collecting and analysing data

The first stage in the process is the collection and analysis of data during the 'before' period which is relevant to making the following decisions:

- the selection of which route or routes require treatment or would be most likely to benefit from treatment;
- the selection of a suitable treatment;
- the level of consultation;
- the selection of measures upon which the success or otherwise of the treatment can be evaluated.

In the ideal situation, all available routes would be prioritised according to the likely costs and benefits of treatment. The routes with the highest estimated benefit/cost ratios would then be selected for treatment. The approach might extend from modest 'back of the envelope' assessments to full blown scheme analyses. Accident and casualty reductions would not be the only benefits considered, but the effects on journey times, vehicle operating costs, emissions and other economic or environmental factors would also be included in the making of decisions. For the purposes of this guidance, it will be assumed that accident and casualty reductions are the main aim. However, this should not mean the data that is considered is restricted to accident and casualty numbers.

Although a period of three years is often considered to be sufficient for these purposes, a 'before' period of five years or more is better when considering accidents which are not clustered. Clearly, if the sole intention is to treat non-clustered accidents then only these should be considered in the selection process. However, the selected treatment may produce unforeseen reductions (or increases) in other accidents so from the point of view of 'before' and 'after' comparisons, it is more prudent to consider the effect on all accidents in addition to those that are targeted. (This principle will also apply later, when the particular accident type(s) being targeted has (have) been selected.) The suggested period of five years represents a balance between a shorter period in which there may be too few accidents on which to base comparisons and a longer period whereby other conditions change so much as to make 'before' and 'after' periods incomparable.

In identifying routes for treatment, it is often helpful to consider investigatory levels. Routes with values higher than the national average warrant further investigation. Investigatory levels for rural roads have been published (TRL, 2004).

Care must be taken when using investigatory levels. If a value for a particular route exceeds the corresponding investigatory level, it does not prove that a problem exists as the investigatory level represents a national average level. Most roads will not have values equal to the average and a particular local value may reflect different levels of exposure locally from nationally. Even where a local value is less than the national investigatory level, this could nevertheless camouflage a particular local problem. In spite of these difficulties, the use of investigatory levels is a valuable method of identifying accident characteristics that warrant further investigation.

Although it is important to tackle the largest number of accidents and casualties possible with the budgets available, it is important to note that, despite this, this does not necessarily mean treating the routes with more accidents. This is because routes with a high accident risk (routes that do not necessarily have the largest numbers of accidents, but do show a greater propensity for accidents than would be expected for a given level of exposure to risk) are the routes that are the more likely to be amenable to treatment.

The regression to the mean effect can be a substantial issue when 'before' accident numbers or rates are used to select routes that are suitable for treatment if the success of the treatment is to be based on a comparison with the values in an 'after' period.

The difficulty can be reduced if several routes which have similar accident problems and similar traffic flow and other characteristics can be found. These are then allocated at random into a treatment group and a control group. One group are treated and the other group is not. If the treatment is effective, a reduction in accidents will be expected in the treated group but not in the control group.

The use of controls is important not only as a way of reducing the impact of regression towards the mean effects but also to take account of trends in accident numbers and rates. These trends tend to be downward so that if controls are not used an ongoing downward trend may be mistakenly attributed to a reduction caused by the treatment if 'before' and 'after' comparisons are made. It may be argued that trends and step changes can be recognised by plotting time series of accident numbers or rates, but unless the numbers are very large, these are not likely to be able to be reliably distinguished.

Although accident and casualty rates provide key information about the safety of a route, other sources of information may be useful, for example, the 'contributory' factors relating to the accidents, assessments along the lines of EuroRAP and local knowledge.

The 'before' data will require careful analysis and comparison with controls and, in addition to average accident rate and severity, might include consideration of the use of the road and the types of accident that occur; for example:

- road user type;
- junction and non-junction locations;
- time of day;
- road condition;
- driver profile;
- and other factors.

Depending on the results of the initial analysis, it may be necessary to collect additional data to help understand the reasons for the safety problem. This may include behavioural measures, as discussed previously, as well as:

- junction density;

- bendiness;
- hilliness;
- road widths and alignment;
- visibility;
- road markings;
- signing;
- lighting;
- route consistency;
- time headways;
- overtaking rates (net number of overtakes per unit flow per unit length);
- lateral position in the lane.

Some of these issues may realistically be outside the control of the local authority. For example, reducing 'hilliness' will rarely be cost-effective. However, taking these factors into account may aid understanding of the accident rate – a road with a higher junction density will, on average, have a higher accident rate than a similar road with a lower junction density, for example.

4.3 Choosing the package of interventions

Once the relevant data has been collected and analysed, it will be necessary to select a suitable package of interventions.

A route may need attention for many reasons. There may be a number of bends which each has a small number of accidents, or a stretch of road where there are a number of overtaking accidents or right turn accidents. There may be parts of the route which pass through or close to built-up areas where pedestrians are walking alongside or crossing the route or where cycle flows are high. It may be that there are especially high flows of heavy goods vehicles or of two-wheeled vehicles.

Whatever the accident problems along the route it is important to design and treat the route as a whole, not a sum of parts. The aim is to provide a predictable road environment for the driver by designing a route treatment which incorporates:

- consistent types and levels of signing and marking appropriate to the road geometry, especially at different types of bends and junctions;
- consistent speed limits;
- clear, uncramped directional signing;

- devices to alert drivers to unexpected hazards or the elimination or the mitigation of such hazards;
- the end points of the treated route should be compatible with the adjoining sections of road.

The treatment may involve not only engineering interventions but also enforcement, educational and publicity strategies. A key point is that locations along the route that currently do not have accident problems will be treated in the same way as those that do, provided they have the same characteristics. This will lead to a consistent approach along the whole route.

So far consideration has focussed on interventions designed to address the specific accident problems identified in the analysis. However, removing the problem this way may be too expensive or the characteristics of the accidents may be too varied to allow a specific problem to be identified. In these cases, blanket mitigation interventions may be desirable, which aim to reduce all types of accident. An example of this might be the use of markings designed to reduce speed.

In addition interventions which reduce accident severity should be considered. These will often be the same interventions that are designed to reduce accident numbers. However, some interventions are particularly focussed on reducing severity, given the involvement of a vehicle in an accident, for example, by removing or protecting roadside features.

There are many forms of intervention which have been used. Examples of those suitable for both urban and rural roads are:

- gateway treatments;
- signs and markings;
- passively safe signs, posts and lighting columns;
- safety cameras (speed, red light running and use of seatbelts);
- and media campaigns.

Examples of those particularly suited to urban roads are:

- pedestrian crossing and refuges;
- median treatments;

- 20 mph speed limits;
- widened footways;
- and kerb build-outs.

Examples of those particularly suited to rural roads are:

- speed limit review;
- within village treatments;
- bend treatments;
- wide single 2 and 2+1 designs;
- 'Route Alert' type signing.

4.4 Consultation, implementation and maintenance

Consultation is as important for route treatments as it is for single site treatments. It may be necessary to consult with a range of people and organisations who are located along, or are likely to use or depend on, the route.

Route treatments may involve relatively simple interventions at a particular site but the fact that many sites along the route will be treated means that disruption can still be an issue. Phasing of implementation will need careful management. Depending on the scale of the interventions, the potential for alternative routes for through traffic should be considered.

It is important that route treatment schemes which are based on low cost interventions, such as signing and marking, are well maintained, if they are to be effective. Signing must be clearly visible, clean and unobstructed (for example, by vegetation) and where appropriate, well lit. Markings should be replaced or re-laid when necessary. It is usually sensible, especially on highly trafficked routes, to ensure that high quality, hard wearing materials are used to minimise the frequency of maintenance.

Care should also be taken in the choice of materials used for coloured surfacing. For safety schemes which include red surfacing, it is better to incorporate a natural red aggregate, rather than using a non-red aggregate and adding red pigment. This ensures that the colour will not fade.

4.5 Monitoring and evaluating the treatment

A good deal has already been discussed with respect to the 'after' period of monitoring and evaluation. This is because it is necessary to plan these activities from inception.

The use of accident numbers and rates is likely to be of importance only in the longer term since prior to this, unless the treatment has been counter-productive, it is unlikely that sufficient numbers will have occurred to permit a reliable indication. In some cases it may require a period of five years before the position is clear.

This also elevates the importance of behavioural measurements which can be evaluated within a relatively short period of time and if necessary repeated regularly to monitor how things are progressing. The use of accident numbers is still important in the longer term since there is a possibility that, even if the desired behavioural changes do occur, they may not necessarily reduce accidents.

It is also possible that the treatment may change behaviour in ways that were not anticipated. Unless this is very apparent, there may be doubts as to whether there has been a change at all (since 'before' data may not have been collected). However, any such information may be useful in understanding the effects of future interventions.

This process of learning from past successes and failures should not simply be contained within an individual authority, but shared with others. We can all learn from each other. However, it is important that correct interpretations of data are made and that the context is understood since otherwise misleading information will be spread.

The MOnitoring LOcal Authority Safety SchemES (MOLASSES) database contains some such information, though much of it is restricted to 'before' and 'after' casualty numbers. There is also little information about the method of analysis used; for example, how the treatment schemes were selected, whether controls were used and how were they selected, and to what extent statistical challenges such as regression towards the mean were resolved.

Amongst other alternatives is the Greensafe website (www.greensafe.co.uk) and the road safety hub (www.roadsafetyhub.co.uk).

As accidents become more sparsely populated, the use of 'route safety' techniques is likely to become more important in ensuring that money spent on road safety is spent most effectively. Sharing knowledge on what works and, just as importantly, what does not will be a necessary part of the evolution of route safety good practice.

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