INTRODUCING ROAD SAFETY AUDIT IN THE PHILIPPINES

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Abstract: Improving the general level of road safety in any country requires a combination of effort on two main fronts, **accident prevention** and **accident reduction**. The Department of Public Works and Highways (DPWH) is now introducing the Road Safety Audit under the Road Safety Component of the International Bank for Reconstruction and Development (IBRD)-assisted Highway Management Project which deals on accident prevention (to make sure that the design of new road and traffic schemes will provide a more safer road for motorists and passengers alike), trying to prevent accidents from occurring, or to ensure that any accident effects are lessened through a road safety audit process. It is also giving attention to accident reduction (treating of newly constructed or existing road network for safety measures included in the design but were omitted during construction stage). This paper discusses the methods of conducting a road safety audit on existing roads classified as blackspots or accident prone areas in our country.

1. INTRODUCTION

1.1 Background

A pilot project on Road Safety Audit, one of the elements under the Road Safety Component of the IBRD-assisted Highway Management Project was started in the Philippines by the Road Safety Consultants from United Kingdom contracted by Renardet S. A. in 1995.

An Audit Investigation Unit (AIU) Team have been set-up from the Traffic Studies Section (TSS) within the Infrastructure Planning Research and Statistics Division (IPRSD) of the Planning Service of DPWH. The team was divided into three groups and was trained to conduct road safety audit for the total of three (3) months consisting of seminars and fieldworks.

The work of the AIU was not totally committed to the road safety audit as it should be because their involvement in this project is an additional activity to their regular workload in the office. As a result, the team often times has to make a choice which work has priority over the other and this inevitably leads to inefficiency and a longer timetable to complete the assigned task. Hence, their attention or motivation was half hearted towards the project resulting to frequent interruptions of their work. Because of limited time allotted to the AIU for the conduct of the audit during the training work, only 35 out of

60 investigation sites were audited. The 60 investigation sites were selected from the submitted lists of accident prone areas (blackspot) given by the Philippine National Police-Traffic Management Group (PNP-TMG), the government agency in-charge of collecting traffic accident reports nationwide. A road safety audit report in one of the sample sites mentioned is part of this paper.

1.2 Problems Encountered by Road Safety Audit Team

One of the main problems encountered by AIU is the non-availability of the accident data for the past three (3) years due to non systematic data collection of the Police reporting stations. No accident database system exist before the implementation of the road safety audit. The accident data used as the basis on the selection of accident sites to be treated were based on the one or two years existing data which were often incomplete in details.

Inspite of these limitations the introductory stage of safety audit in the Philippines has achieved a degree of success with the team carrying out practice audits in 50% of the expected number of blackspots to be treated. This work has been extended with "stage three" audit being carried out on all sites investigated by the AIU.

This paper reports on some of the major aspects of the road safety audit project and provides a brief introduction into road safety audit, why is it needed, and how its application can lead to safer road network in this country.

1.3 Objective of Road Safety Audit

The main objective of road safety audit is to ensure that all highway schemes should operate as safely as possible: this means safety should be given consideration throughout the whole preparation and construction of the project. The specific objectives are as follows:

- to minimize the risk of accidents on the adjacent network affected as well as on the schemes themselves;
- to enhance the importance of road safety in highway design; and
- to reduce the whole-life costs of a scheme- unsatisfactory designs can be expensive to put right once they are built.

1.4 Why is Road Safety Audit Necessary

Traffic engineers are always concerned with safety of their road designs because previous constructed roads have been found out to be accident prone in some instances. Some of the factors that contribute to the rampant occurrence of accidents along our road network can be attributed to lack of education on the part of motorist and absence of road safety audit. The following problems may occur where no auditing is conducted:

- a design that incorporates standards which are inappropriate for the type of road.
- outdated standards being used in a design.
- the combination of various elements of the design yielding a result which is safety deficient.
- compromises between capacity and safety leading to an unacceptable safety risk.
- changes being made during construction which do not fully consider operational safety factors.

1.5 Benefits of Road Safety Audit

The assessment of benefit is subjective, however, there is evidence that some of the accidents generated by new road schemes are susceptible to low cost remedial measures. Such measures could have been added to the scheme at various stages throughout the design and construction process. More importantly other accidents associated with layout and level features cannot be influenced, other than by major reconstruction of junctions and structures, but could have been changed at negligible cost at the planning and design stages to provide greater safety audit system at all stages in planning, design and construction. Benefits of the order of one-third of the anticipated accidents which is a very conservative estimate is possible. This has been proven in other countries where road safety audit has been in practice e.g. in United Kingdom (UK).

Other specific benefits of road safety audit may include the following:

- improvements to existing design and construction practices;
- community benefits through casualty reduction;
- overall resource reduction over the whole life of a scheme;
- reduced whole life costs of road schemes;
- providing a component of local/national accident reduction targets; and
- fostering the importance of road safety engineering.

1.6 Stages of Road Safety Audit

The question of when to audit will be partly determined by a particular organization and the procedures it chooses to use and the type of scheme involved, whether it is urban/rural/large/small. The following stages may be relevant for new or improved roads:

Stage1 - As an input to feasibility/initial design of schemes. Particularly for major schemes in urban areas, the audit is able to influence route choice, standards, impact on and continuity with existing network, junction provision (number/type). Not all these factors will be applicable to small improvements but some will be relevant. Typically 1:2500 scale plans are used for this audit assessment.

Stage 2 - On Completion of Design. To assess horizontal and vertical alignments, sightlines and layout of junctions. Assessment of road markings, signs, signals and lighting details are made at this stage. After this stage land stake may be firmly

established and scope for further alignment changes will be limited. It may be appropriate, on large schemes, to split this stage into two sub-stages. The first at the conclusion of the preliminary design stage and the second at the end of the preparation of detailed designs. Plans at 1:500 scale are usually sufficient for most stage 2 audits.

Stage 3 - Immediately prior to opening of scheme. This should take the form of driving, and when appropriate, walking or cycling the new route including all junctions, newly constructed or existing. These should be approached from all legs, undertaking all possible (whether legally allowed or not) movements. The scheme should also be examined during the hours of darkness to ensure that suitable night time safety standards have been achieved.

Stage 1 will usually be unnecessary for traffic management or major maintenance works. It may also be necessary to audit some major schemes during construction to appraise the appropriateness of temporary traffic arrangements.

1.7 Method of Organizing Safety Audit

Where safety audit has been formally introduced it has usually been organized using a specialist safety engineering team - those who are also involved with accident investigation. There are a number of ways in which a safety audit team can be organized however the following three methods are to be recommended.

Method 1. This method involves setting up an independent unit of specialists. The safety adviser and audit team do no design work at all but carry out safety audits on schemes prepared by other staff involved in this work. The team may also investigate accidents and provide advice on remedial measures for action by others. Formal approval (in the form of a "safety certificate") is required from the team before proposals can proceed to the next stage of design.

This method requires the full support of all senior staff in the Department. It is recommended as the best way to proceed when setting up new safety audit procedures.

Method 2. The project is audited by the staff specializing in accident investigation work in which a report is prepared and submitted to a third party who decides what action to take and instructs the designer accordingly. The third party should be a senior member of the organization with no direct line management responsibility for the design team. This is the method used in the Philippine set-up of the road safety audit because it is less bureaucratic, and can result in the immediate incorporation of remedial measures to be recommended in the projects audited. This method was also recommended by the road safety specialists since road safety audit is still in the introductory stage in our country. However, instead of specialists carrying out the audit work, traffic engineers and their staff did the work with the road safety specialists acting as the safety adviser. During visits to accident sites the team is always accompanied by police officers who is knowledgeable of the accidents that occurred in the area.

There is much value in having an independent assessor who compare the safety audit recommendations against the original design. This reduces the possibility of conflict

between design and audit staff, and frees the audit staff from judgments regarding the relative value of safety and other scheme objectives. If the advice of the audit team is not followed a formal note of the reasons why the audit advice has not been followed should be recorded by the project manager or the independent senior managers.

Method 3. The audit is similar to the second method but the report is submitted directly to the original designer, who decides what action to take. In these circumstances, the reasons for rejecting all or part of the audit team's advice should be formally documented by the designer to make the accountability clear for the necessary decisions. In this method, the project is audited by the staff specializing in accident investigation work unlike in the first method wherein an independent unit of specialists conducts the audit. The audit staff submits their report to a third party who must be a senior member of the organization, in our case he can be the Director of a Bureau or a Service with no direct line management responsibility for the design team.

If the full benefits of the audit are to be achieved, it is essential to adopt one of the three methods described above.

1.8 Cost of Road Safety Audit

The cost of road safety audit includes:

- the audit costs (mainly the time of the auditor/team)
- redesign costs where applicable
- any increased project cost.

2. ESTIMATING THE COST OF IMPROVEMENT/TREATMENT OF AN ACCIDENT BLACKSPOT SUBJECTED TO ROAD SAFETY AUDIT

The economic objectives are expressed in terms of the First Year Rate of Return (FYRR) to be achieve at each site. The FYRR is a simple practical method of economic evaluation which is widely used.

The cost of a scheme for accident reduction is constrained by the benefits expected. There is scope for many "low cost" schemes (e.g. minor re-alignments, additional traffic islands, signing and road marking schemes) within the Philippines. However, it should be recognized by authorities that high accident levels in dense urban areas can often justify schemes involving major works (e.g. road or junction alignment or even grade separation) where the threshold FYRR is easily met.

2.1 By Using The First Year Rate of Return (FYRR)

In the initial stages of assessment it may be important to calculate approximately how much money should be spent on the improvement. This is done by setting a target rate of return, and using a simple FYRR formula.

Table 1 Accident Situation in Rural Area

Accident Situation	Remedy	Approximately Expected Percent (%) of Accident Reduction
Junction:		
-turning traffic	channelization additional lanes (acceleration, deceleration) traffic islands (real or ghost) prohibition of turn roundabout or traffic signals	general relation wide variation in savings 30 - 50 % offset traffic island 50% reduction yellow bar markings 50% reduction, rumble areas 35%
-overshoot from minor road	traffic islands	30 - 50% reduction
- overshoot at roundabout	chevron, warning signs yellow bar markings	50 - 80 % reduction
-collision while waiting	traffic islands, widen approach	30 - 50 % reduction
-restriction of sight	relocation of minor access removal of vegetation realignment of oblique angle intersection adjustment of minor road profile	50 - 80 % reduction
Non-junction:		
-overtaking -prohibited lane	double white line markings	miscellaneous improvements
-bend loss of control	superelevation, re-alignment advisory speed, road surface, signs	bends and alignment, 60-80% reduction in accidents
-trucks on hills	crawler lanes, run-off provision	60 - 80 % reduction
-opposing vehicles on crest	double line markings/deflection arrows	50 - 80% reduction
-excessive speed	enforcement carriageway definition	30 - 50% reduction
-	rural bypass	50 - 80% reduction

Source: Technical Note, Road Safety Audit Guidelines, IBRD Assisted Highway Management Project-Road Safety Component

Analysis of the accidents reveal those that are "treatable" with remedial measures. These treatable accidents can be expressed in economic terms as potential accident savings. The FYRR method can be used to calculate the maximum scheme cost required to achieve a target rate of return, assuming that all of the treatable accidents will be saved.

$$\% \text{ FYRR} = \frac{\text{Annual Accident Savings} * 100}{\text{Scheme Cost}}$$

2.2 By Computation of the Detailed Estimate of the Dominant Factors or Feature to be Improved Per Accident Site.

That is the approximation of the cost of treating a particular problem identified by the audit team. The relevant accident factors are listed in Table 1 which represents commonly encountered situations related to the dominant factors or features identified at an accident site.

3. DATA COLLECTION

3.1 Procedure of a Road Safety Audit
(On an existing Road Accident Blackspot)

1. Basic information must be collected first: Due to limited funds allotted forthe Road Safety Program of our country, there is a need to prioritize projects to be considered for road safety audit and consequently to be treated. Prioritization of accident prone areas to be audited depends largely on the frequency of occurrence and/or severity of accidents in a particular road section. To be able to get reliable accident data it is recommended that a historical data for a particular site for the past two (2) years be gathered.

   Information on what standard was used (whether Philippine or other country) in the design of the road is crucial during audit to give the AIU team who are conducting on-site visits a basic comparison with the existing road being audited. Any deviation from the original design and the reasons for the departure from using the standard, if there is any is also very important as they may be one of the contributory factors in the cause of accidents.

   It is very important that the time and exact location of accidents occurring in an accident prone area is taken into consideration. Accidents involving pedestrians usually happen in populated areas and the presence of local factories/schools in the vicinity of the site can mean workers and students crossing the road to use public transport. If this is the case, then installation of pedestrian crossing and/or traffic signs to this effect may solve the problem.

2. Site visits (ocular inspections) should be undertaken during daytime and night time to assess local conditions. The presence of local factories/schools in the vicinity of the site; workers and students crossing the road to use public transport; lighting

Table 2 Sample Safety Audit Survey from Training Site

Safety Principles	Description	OK? (/, x, or ?)	Comments
1. Geometric Design	Are carriageway and lane widths adequate?	/	Road width is 7 meters consisting of 2 lanes
	Are acceleration/deceleration lanes necessary and if provided are radii OK?	X	Sharp curve.
	Is crossfall and drainage satisfactory?	X	Open line canal is obstructed.
	Are sight and stopping sight distance of the horizontal and vertical alignment OK?	?	Stopping Sight Distance (SSD) is poor.
2. Surface Characteristics	What is the condition of the road surface ?	?	Slippery when wet.
	Are the surface treated with anti-skid materials?	X	No skid resistance.
3. Road Surface and Marker Post	Are road markings satisfactory?	X	Road markings are faded. No reflectorized raised pavement markers (or "stud") on curves.
4. Road Signs Furniture and Facilities	Are advance warning signs adequate?	X	Lack of chevron signs and no speed limit sign installed.
	Is the road subject to speed limits?	/	40 kilometer per hour
	Is street lightning required and adequate?	/	No electric lights along the area.
	Is guardrails necessary to direct/protect motorists?	/	No guardrails installed along the deep ravine.

facilities present in the sample site especially if most accidents occur during night time; road repairs going on in the vicinity of the site; and the presence of Bus/PUJ stops or terminal.

These site visits is different from an ordinary hazardous location investigation in the sense that this procedure requires the identification of road safety furnitures which need to be installed in an accident site to reduce if not prevent future accident while the latter is more concerned in the identification only.

3. Examination of plans in comparison with the existing geometric design of the road. The road safety auditor should look for the interaction of the design element on each other and their effect on road safety.

4. Writing a report to present the findings and recommendations for any change to improve road safety of the road if necessary.

5. Estimating the cost of proposed improvement using the FYRR method (Approximate estimation) or by detailed estimate of particular work/improvement to be done on the road section.

6. Submission of the Audit Report to the concerned authorities for approval and or funding purposes.

3.2 Survey Content

The data shown in Table 2 is the list of some elements and features which do not comply with the standard specified for the road's functional status from the safety audit. The geometric design has been checked for compliance with the appropriate criteria. The legibility and intelligibility of road markings and signs were also checked for the benefit of the local traffic. Surface texture was also assessed to determine the skidding resistance of the road.

4. DISCUSSION OF ROAD SAFETY AUDIT RESULT

4.1 Sample Audit Report on an Identified Accident Blackspot

ROAD SAFETY AUDIT
Training Site No. 1
Marcos Highway, Km. 278+000 - Km. 279+000
Barangay Badiwan, Tuba, Benguet
Cordillera Administrative Region, Philippines

4.1.1 Introduction

The audit consisted of site visit to the section and pinpointing traffic hazards along the area. Road diagram and bridge list (Straight Line Diagram) was also used to

countercheck strategic points and landmarks along the area without kilometer references. Problems referred to in this report are those that are considered urgent only. The group also coordinated with the local Philippine National Police (PNP) unit in the gathering of police reports for the last 2 years (Traffic Accident Investigation Report) that occurred in the blackspot area. The road safety audit was conducted by Group 2- Accident Investigation Unit (AIU) composed of personnel from the Traffic Studies Section, Infrastructure Planning Research and Statistics Division (IPRSD), Planning Service. This was carried out last March 12-18, 1996.

4.1.2 The Study Area Description (Training Site)

Marcos Highway is one of the main access roads going to Baguio City. The training site at Brgy. Badiwan is a winding road with steep curves. The road is concrete with the width of 7 meters consisting of two lanes. The coordination of the vertical and horizontal alignments in some sections of the road is poor which contribute to accidents. Generally, the volume of traffic along this road section is moderate but during summer season the volume increases due to the influx of tourists to the city of Baguio. The road section is also slippery during wet season which is one of the causes of vehicular accidents in the area.

4.1.3 Problem and Recommendation

4.1.3.1 Geometric Design

Problem
The sharp curve at Km. 279+500 has a very poor stopping sight distance of 60 meters which restrict the line of sight of drivers negotiating the bend from both directions.

Recommendation
Widening the curve to increase the stopping sight distance to conform with the maximum required design speed (40 kph) of vehicle traveling along the curve.

4.1.3.2 Road Surface Characteristics

Problem
Road surface is slippery especially when wet which causes skidding of vehicles.

Recommendation
Drainage must remain free of obstruction and retain their cross section and grade.

4.1.3.3 Road Markings and Marker Post

Problem
Lane marking is faded.

Recommendation

Re-paint lane markings using thermoplastic paint or place studs pavement markers especially on bends to discourage overtaking of vehicles along the bend.

4.1.3.4 Road Signs, Furniture and Utilities

Problem

a. Lack of chevron signs on the steep curves along the road section.
b. No speed limit sign along the road section.
c. No guardrails along the side of the deep ravine.

Recommendation

a. Chevron signs should be installed on both directions to warn the drivers of the curve ahead.
b. Speed limit sign of 40kph should be installed before approaching the curve to warn motorists to slow down from speedy maneuver.
c. Install guardrails to avoid vehicles falling into the ravine during accidents.

Problem

No electric lights along the highway.

Recommendation

Install street lights to give enough lighting facilities in the area.

4.1.4 Computation of Scheme Cost

In this sample site, there were ten (10) accidents that occurred in 2 years. If the target rate of return (FYRR) is set at 50% and the average cost of an accident is assumed to be P500,000.00 (approx. estimate) and the average accident reduction of treated site is 33% then the maximum budget for the scheme can be roughly calculated as follows:

$$\%\ FYRR = \frac{\text{Annual Accident Savings} * 100}{\text{Scheme Cost}}$$

$$\text{Scheme Cost} = \frac{\text{Annual Accident Savings} * 100}{\%FYRR}$$

$$\text{Scheme Cost} = \frac{[(1/3)(10/2)(P500,000.00)] * 100}{50}$$

Scheme Cost = P1.6 M

4.1.5 Audit Team Statement

This road safety audit report is not too comprehensive but we did our best to produce a presentable report. The problems identified were what we observed in the field. We

certify that we were on the site during the audit and that what we observed was worth reporting.

This audit report is still subject for final approval by the road safety consultant from Renardet S.A. contracted under the Road Safety Component of the IBRD-Assisted Highway Management Project.

5. CONCLUSION

The main beneficiary of safety audit will be those who travel on the highways, by whatever mode. The traveling public should be presented with a consistently safer roads so that the incidence of adverse highway factors contributing to accidents is extremely low.

There are benefits from road safety audits, most of which can be achieved at low cost. The earlier the audit is carried out in the design process, the easier and cheaper it is to achieve the benefits.

Road safety audit will not necessarily make every new design totally "safe" but it will put road safety consciousness high on the decision-making agenda. It will also cause deliberate decisions to be made on the basis of carefully considered safety advices.

Road safety auditing should be part of the total quality management approach to road design and network management. It provides the means to direct importance on the safety principles and practices of road network delivery and to remedy or correct safety deficiencies before road users are exposed to them.

Safety audit process has the benefit of not only improving the safety of the schemes themselves but also of evolving design standards to produce safer roads.

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