

ROAD SAFETY AUDIT: A CASE STUDY

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As a consequence of increasing traffic volume and mobility, road accidents have been a serious problem especially in low and middle-income countries. The number of road accidents in such countries tends to increase every year. Considering different contributing factors to the road accidents, road and its environment have played an important role. Road safety audits and road safety inspections have been worldwide used tools to monitor and to evaluate road projects and existing road sections from the safety perspective. In this study, through the evaluation of different safety auditing techniques applied in the world, a case study on a Nigerian Road Section has been implemented. The expectations from such a study are: (i) To show the main safety deficiencies of the Nigerian road sections; and (ii) To introduce a new tool to the local road authorities to further use it for monitoring their road sections. Based on this study, the audit report was prepared to summarize findings with possible countermeasures.

Keywords: Traffic accident, Accident prone locations, Clear zone, Deficiency, Nigeria, Kano-Kaduna, Highway.

1 INTRODUCTION

Road traffic accidents' deaths and injuries have been observed worldwide. It was estimated that over 1.2 million people died each year on the world roads as a result of road traffic accidents. According to a survey by World Health Organization (WHO) more than 3,200 people get killed and over 130,000 injured in traffic every day around the world (World Health Organization 2009). Also, almost half of all fatal accidents involve pedestrians, cyclists and power two wheelers, collectively called vulnerable road users.

It is observed that more than 85% of accident fatalities occur in low and middle-income countries such as Nigeria. Though road fatality rate in high income countries has been decreasing over the last decades, even in these countries road accidents remain one the main causes of death, injury and disability (Nigeria Federal Road Safety Commission 2011).

Road and its environment have played an important role among different contributing factors of the road accidents. Regarding that fact, road authorities in different countries have tried to design, build and operate more safe roads. Special concentration has also devoted to have and to keep safe road environments by allocating clear zones on both sides of the road platforms.

Through the mentioned efforts, studies have also been devoted to find accident prone locations along the roads. After investigating these locations, they are further evaluated to select and implement correct measure for the safety improvement of the road section. They are also investigated to define the design deficiencies thus for upgrading design standards of the future roads from safety point of view.

Road safety audits and road safety inspections have been worldwide used tools to monitor and to evaluate road projects and existing road sections from the safety perspective. In these techniques, road structure and its environment are checked whether there is any hazardous situation and/or questionable design parameter exists that might lead traffic accidents in the recent future. To early clarify such potential risky situations can help to implement low cost measures before facing high amount of accident costs thus enables to apply cost-effective improvement steps.

In this study, different safety auditing techniques applied in different countries have been evaluated. Following that evaluation, a methodological approach has later been selected to implement a case study on a Nigerian Road Section.

In the subsequent chapters, the approach and the case study road section has been introduced. The results of the auditing study will be presented.

2 THE METHODOLOGY AND THE CASE STUDY ROAD

2.1 Practices and a Methodological Approach

A Road Safety Audit (RSA) is a formal safety performance examination of an existing or future road or intersection by an independent audit team. The RSA team considers the safety of all road users, qualitatively estimates and reports on the road safety issues identified, and presents suggestions for safety improvement.

There are several different safety auditing practices in all over the world thus European Union has continued a harmonization study to have a common practice for the member countries. In United States (US), there have also different practices which in fact based upon a similar structure. In this study, among these, the US Federal Highway Administration (FHWA) Road Safety Audit Guidelines has been followed (European Transport Safety Council 1997).

2.2 The Case Study Road

For the application of the selected methodology through a case study implementation on Nigeria Roads, a 50 km section of Kano-Kaduna express way has been selected. This road section is a part of a dual carriageway road which connects two major cities having high populations in Nigeria and also many towns that have been located along the same road section.

All necessary information and data required about the route were collected from relevant authorities before going to the site for observations. The data set includes available traffic counts, land use patterns, speed levels and accident blackspots if there is any. At particular accident data was obtained from both Nigerian Police Force and Federal Road Safety Corps of Nigeria at their offices in Kano and Kaduna States.

After gathering all the road and the environment information around, audit surveys on the case study route were started from Na'ibawa interchange which selected as a starting point and marked as 00 + 000 km. Features like lane width, shoulder width, median type and width, road side clear zone, traffic volume, posted legal speed limit, surroundings or land use and other elements were observed and analyzed during the auditing studies.

While evaluating limiting conditions and missing features, American Association of State Highway and Transportation Officials' (AASHTO 2010) design manual has been referred. The technical comparisons have been made by classifying the observed road section as a multilane rural arterial highway which reflects its function and operating conditions. Although efforts have been devoted to reach the national design standards, AASHTO reference has further been selected to forward some technical design limitations compared with the locals. Photographs and video

records were also made during the site visits which are used for subsequent comments and discussions on observed hazards during the field survey. Both sides of the audit route were observed and all safety audit aspects of the road were recorded during the site survey by referring a safety audit checklist for existing roads.

3 RESULTS AND EVALUATIONS

3.1 Comparisons with the Standards

The existing geometric parameters of different cross sections on the audited road are compared with AASHTO Highway Design Manual (Multilane Rural Arterial Highway) and the results are displayed in Table 1.

Table 1. Available design comparisons with AASHTO Standards.

Number	Roadway Element	AASHTO Standard Values	Observed Values
1	Design Speed	60-120 km/hr Depending on the terrain	100 km/hr
2	Number of lanes	Four or more	Four lane
3	Travel lane width	3.6 m minimum	3.3 m
4	Right shoulder width	2.4 m	0.0-2.2 m
5	Left shoulder width	1.2-1.8 m	0.0-1.0 m
6	Turn lane width	3.6 m	0.0
7	Median width including left shoulders	Wide median 7.5 m minimum	4.0 m
8	Roadside clear zone	9 m	0.0
9	Fill/Cut slope	4H:1V	5H:9V
10	Min. bridge vertical clear	6.248 m	4.5 m
11	Bridge width	Full approach traveled way width	2/3 of traveled way width
12	Control of access	Partial/by regulation	Uncontrolled access
13	Alignment	Adequate & smooth flowing alignment	Poor alignment
14	Bus turnouts	A better marked widened shoulder or an independent turn out	No widened shoulder or independent turnout
15	Pedestrians crossing	Controlled	Uncontrolled

Travel lane width, shoulder widths, median width have been found as insufficient whereas there have been almost no safety zone considerations. Side slopes were found as steep with bridge vertical clearance limitations. Access control and pedestrian facilities were also quite limited thus adversely affecting the overall safety situation of the observed road section. Overall alignment features including bus stops' layouts were also found as inappropriate.

3.2 Typical Observed Hazards and Proposed Countermeasures

The most common and dangerous hazards which were observed and classified are dangerous fixed objects on roadside, missing shoulder, improper junction design, potholes, improper commercial activities layouts on road sides, improper bus stop locations, dangerous median openings, edge deterioration and missing signs. Majority of these hazards were associated with the road side safety.

Some typical observed hazardous situations from the case safety auditing study have been summarized as follows:

- (i) **Missing/ Inadequate Safety Zone:** A Clear Zone is an unobstructed, traversable roadside area that allows a driver to stop safely, or regain for control of a vehicle that has left the roadway. At the case study road, the width of the safety zone is almost zero at majority of the roadway and maximum of three meters at few places along the road which is not sufficient and not in accordance with the standards. Proposed countermeasure is design and application of clear zones on both sides of main highways.
- (ii) **Utility Poles and Tress in the Safety Zone:** Utility poles and trees can cause severe roadside crashes. Along the audit route the most noticeable ones are electricity poles that are made of concrete and telephone poles that are made by wood. They are all located within the safety zone area on both sides of the route. Proposed countermeasure is implementing guardrails while waiting clear zone applications.
- (iii) **Improper Signing and Marking:** Most of the information signs have been located at inappropriate locations and are not in accordance with the standard and all the markings on both sides of the route have been completely worn out to the extent that drivers cannot even see any indication. As a result of that drivers have used the road with no markings and inappropriate signing which might contribute to the road accidents. Proposed countermeasure is improving signing and marking.
- (iv) **Improper Shoulder Widths and Danger of Edge Deterioration:** The shoulders observed on both sides of the road during the audit survey have been generally quite limited in their widths and almost all unpaved. There have been some other sections in which shoulders are also completely missing. Apart from missing and inadequate shoulders on the road; there has also been another serious problem of edge deterioration at majority of the roadway parts which causes serious safety and structure problems along the road. Proposed countermeasure is design and implement paved shoulders by referring to the geometric standards.
- (v) **Improper Market Location or Commercial Activities and Improper Bus Stop Layout:** During the audit survey it was noticed that there have been many locations on both sides of the road in which small markets and many other commercial activities were located very close to the road platforms. It has also been observed that almost all bus stop layouts are out of standard thus also creates danger to the road users. Roadside layout designs should be improved.

Some samples from observed hazardous features during the study are displayed in Figure 1. The complete list of observed hazardous features for both directions is displayed in Table 2.



Figure 1. Some samples from observed hazardous features along the studied road sections.

Table 2. Most common and dangerous hazards observed during safety auditing study.

KANO-KADUNA DIRECTION	
KILOMETER	MOST COMMON AND DANGEROUS HAZARDS OBSERVED
00-05	Dangerous fixed object on road side, missing shoulder and improper junction design
05-10	Missing shoulder, potholes, improper commercial activities and improper bus stop location
10-15	Potholes and dangerous fixed objects
15-20	Limited sight distance improper trees on road side
20-25	Missing shoulder and improper bus stop location
25-30	Potholes and improper connection to petrol station
30-35	Missing shoulder, improper median opening and improper commercial activities
35-40	Potholes and big trees close to the roadway
40-45	Missing shoulder and improper commercial activities
45-50	Potholes and edge deterioration
KADUNA-KANO DIRECTION	
KILOMETER	MOST COMMON AND DANGEROUS HAZARDS OBSERVED
00-05	Dangerous fill slope and fixed massive poles close to the roadway
05-10	Missing signs, pavement damages and improper connection to petrol stations
10-15	Potholes and dangerous supports for advertisement signs
15-20	Dangerous trees on the median and missing shoulder
20-25	Fixed massive poles and improper commercial activities
25-30	Dangerous fill slope and fixed massive poles close to the roadway
30-35	Improper junction design and pavement damages
35-40	Improper median opening and junction design
40-45	Missing shoulder and improper connection to petrol station
45-50	Dangerous trees and fixed massive objects very close to the roadway

4 CONCLUSIONS AND RECOMENDATIONS

Some of the conclusions together with some recommendations that can be drawn from the research study can be summarized as follows:

- (i) Lack of adequate accident data and its proper evaluation have limited all road safety activities including road safety planning and auditing. With the availability of such study, there will be an opportunity to compare safety auditing results with the accident location and accident cause investigation results. It will increase the effectiveness of the auditing studies.
- (ii) All road safety improvements need monitoring so that a dependable 'safety intervention-its possible effect' local databank can be formed. Such a data bank will further help to develop cost effective countermeasure selection processes for blackspot management.
- (iii) Safety auditing and inspection can be accepted as proper tools to operate and monitor more safe roads. They also serve to achieve improved road design standards to have safer roads.

References

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 European Transport Safety Council, *Road Safety Audit and Safety Impact Assessment*, 1997.
 World Health Organization, *Global Status Report on Road Safety*, Geneva, 2009.