Using safe system approach to analyse road infrastructure causes of road accidents on Yaounde-Bafoussam road

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Abstract

Background: The road provides 90 % of the world's transport. Though it has many advantages, it is also the real cause of the biggest tragedy of humanity: road crash accident. Road crash injuries are the 8th leading cause of death globally (1.3 million on the latest WHO estimates, 2018); 90% of these deaths occur in low- and middle-income countries. Among factors that influence Road Traffic Accidents (RTAs), road infrastructure has been pointed out by certain authors as something to take into account.

Objective: The objective of this research was to identify the influence of road infrastructure on RTAs, using the Safe System Approach, as a means to propose measures to improve road safety and to reduce accidents on theYaounde-Bafoussam road axis.

Materials and method: The study used a mixed method (qualitative and quantitative) including first of all, a site recognition through documents and site visit with the objective to collect the geometric parameters and the general condition of this road axis to get which parameters are responsible for road crashes. Secondly, the accident data on this axis was collected in the "Secretariat d'Etat à la Defense" (SED) database over a period of 2 years (from January 2019 to December 2020). Finally, a quantitative analysis of these data has been carried out with Microsoft Excel software, using accident frequency and the Injury Severity Density (ISD) criteria and field investigations at black spots locations in order to bring out optimal solutions.

Results: This analysis showed that, on the one hand, the most critical road sections are the straight lines followed by the curves, which alone respectively count 62.75% and 23.53% on a total of 102 accidents recorded. Head-on and rear-end collisions are the most important representing respectively 35.29% and 21.57% of accidents. Road conditions and speeding are the major causes, responsible of respectively 18.06% and 16.90% of accidents. On the other hand, this analysis has helped to design a map of black spots on the Yaounde-Bafoussam axis, using ArcGIS software. This map presents the most accident-prone locations of which the most critical is the section linking Akak II to Kometou I, with the highest severity index (5.77).

Solutions: At the end of this analysis, the following main solutions were proposed: the adoption of a single speed limit (80 km/h) except at specific points, the increasement of the number of lanes (2x2) of the Yaounde-Obala section, the installation of audio-tactile marker lines, the enlargementof the shoulder's width (2 m), the regular maintenance of roads, guardrails, and horizontal and vertical signage.

Keywords: Safe System Approach, Road safety, Road crashes, Road accident, Infrastructure parameters.

List of abbreviation

SED Secretariat d'Etat à la Defense

ISD InjurySeverity Density
MINT Ministry of Transport
PDO Property Damage Only
RTAs Road Traffic Accidents
WHO World HealthOrganization

INTRODUCTION

The road provides 90 % of the world's transport. Thoughit has manyadvantages, itisalso the real cause of the biggesttragedy of humanity: road crash accident. Road crash injuries are the 8th leading cause of deathglobally (1.3 million on the latest WHO estimates, 2018), the lead killer of schoolchildren and youngadultsagedbetween 05 and 29 and, the leading cause of post-traumatic stress disorder (PTSD). African road trafficdeath rates are the highestglobally and more than four times higherthan the Europeanaverage. With just 2% of the world's cars, Africa contributes 16% of road deaths and 44% of global pedestrian and cyclistfatalities. Moreover, large increases in motorizedtraffic are expected, for which existing and developing African trafficsystems are insufficiently prepared(Force, 2019). In Cameroon, over 16500 accidents are recorded every year with an average of 1200 deaths and 4000 to 5000 injuries, including dozens disabled for life eachyear. The material damage of these accidents isvalued at over 100 billion CFA francs per year, equivalent to 1 % of the gross domestic product (UNECE, 2018). The most accident-prone axes as reported by the Ministry of Transport (MINT), with 70 % of all accidents, are the Douala-Yaounde, Yaounde-Bafoussam and Bafoussam-Douala axes, commonly called "Triangle de la mort"(NGHEMKAP, 2010).Cameroon's national road No. 4 which connects Yaounde, the political capital to Bafoussam, is a part of "Triangle de la mort", not only because of its triangular shape but also because of the countless deaths that occur on this axis every year.

As reminder, there are three major factors influencing RTAs which include the road environment, the vehicle and human factors(Elefteriadou, 2016). Human factors such as over speeding and distraction are also emphasized as being the main factors of RTA irrespective of the environment and the vehicles(WHO, 2009). Saying that over speeding is the main cause of RTAs is not always true for developing countries where road infrastructures are poorly maintained and, in some cases, nonexistent. Researchers have identified inadequate road infrastructures as a possible cause of RTAs in developing countries.

The state of the road infrastructure on the national road No. 4 is often denounced as an explanatory variable for the high number of crashes registered on this road. The main complaint is with regards to the poor state of the road surface which is not regularly taken care of. Conscious that this is not the only problem present, the question of which road infrastructure parameters have an influence on road crashes on the national road No. 4, and how they can be ameliorated is asked. The main objective of this research is to identify the influence of road infrastructure on RTAs, using the Safe System Approach which is more effective in the reduction of road crash fatalities and injuries, as a means topropose measures to improve road safety on Yaounde-Bafoussam road axis.

METHODOLOGY

Study area

The national road 4 links two important cities, Yaounde (Mfoundi division in the Centre region, political capital of Cameroon) and Bafoussam (Mifi division in the West region) passing through Obala, Ebebda, Bafia, Ndikiniméki, Bangangte and Bandjoun. It has a total length of 296 km.

Police reports

Twoyears of accident data (from January 2019 to December 2020) obtained from the SED were analysed to determine the factors that generally influence the risk of accidents, and to obtain the locations where accidents occur. Then, the road parameters obtained from these locations were studied to determine the parameters that needed to beworked on to reduce the number of accidents. Table 1 presents the information relevant for this study extracted from the police reports and grouped on road sections and road intersections.

Criteria for identification of accident-prone locations

The accident data was analyzed using two crash data analysismethods, the crash frequency (CF) and the injuryseverity index (ISD). The CF method counts the number of crashes that have occurred at a given location (alonga roadway section or at an intersection) over a specific period of time. The CF was evaluated using Eq. (1) and compared to a critical value. For road sections, the critical value isgiven by Eq. (2) and for road intersections, the critical value is the average number of accidents recorded on all intersections.

$$CF = \frac{A}{L} \quad (1)$$

Where:
A = Total number of accidents
L = Length of section studied

$$CF = \frac{Total\ number\ of\ accidents}{Total\ length\ of\ road\ (km)} \quad (2)$$

The ISD methodis a detailed variant of the CF; here the crash data is detailed intocategories. Developed in Norway, the ISD represents the average accident severity. It is obtained by weighting accidents differently according to theirseverity (Elvik, 2007); the more serious the accidents, the highertheirweight. The injuryseverity index was evaluated using Eq. (3) for road sections and Eq. (4) for road intersections, and the threshold value evaluated using Eq. (5). The weightage points used were obtained modifying those used in Malaysia (Rahim, Marjan, &Voon, 2013), which are valid for developing countries, to take into account the factthat the collected police reports do not distinguish between severe and slightinjury accidents.

$$ISD = \frac{6 * FA + 3 * IA + 1 * PDO}{L} \quad (3)$$

$$ISD = \frac{6 * FA + 3 * IA + 1 * PDO}{1\ (unity)} \quad (4)$$

Where:
FA = Fatal Accident
IA = Injury Accident
PDO = Property Damage Only
L = Length of section studied
6,3,1 are weightage points

Threshold=(X, M) (5)

Where :
X = Average of ISD values
M = Median of ISD values

Set-up of crash black section map

The identification of the accident-prone locations and the set-up of a mapwasdone as follows:

- Accident data location identified in the Google Earth softwarewe rerecorded and transferred to the ArcGis software(10.8);
- The road was sectionedpaying attention to the Cameroon Geographic Road Referential and intersections into sections of 2-10 km where possible;
- The sections and intersections werenamed;
- The name of the sections and intersections, their correspondin gnumber of accidents and gravity, and length (where applicable) were recorded using Microsoft Excel software;
- This data was analysed using the crash frequency and injuryse verity densitycriteria and the road sections orintersections categorized following the steps in theflow chart in Figure 1;

- The accident-prone locations were highlighted in the Arc Gis software and a map of the accident-prone locations was produced.

RESULTS

After the study of 42 road sections and 20 intersections, it was obtained as accident-prone locations, 3 road sections and 4 intersections as presented in Figure 2.

1. Infrastructure causes of road accidents at road sections

The parameters for presenting the road and ensuring that it meets all the necessary requirements to guarantee the safety and comfort of users were evaluated at these accident-prone sites. These were: the width of the road and the number of lanes, the type and width of the central reservation, the width of the shoulders, the presence of a clearance zone, the access points and access controls, the mixed vertical slope and horizontal curve, the presence and condition of guardrails, the condition of the road surface, presence and condition of side drains, the type and condition of road signs, the availability of rest areas, the presence of visual clutter, the presence of street vendors.

a. Road width and number of lanes

The roads are mainly 2-lanes with width of 7.4 m and 11 m near towns, intersections and markets. But, at the entrance of each principal town (Yaounde and Bafoussam), there are 4-lanes having 2-lanes in each direction with width of 14 m. According to the accident statistic results, road traffic is very important between Yaounde and Obala (because of the superposition of N1 and N4). This is therefore one of the main reasons why major accidents occur in this section (figure 2).

b. Shoulder width and presence of clear zone

The width of the shoulders is more or less 1.5 m. The presence of the clear zone is rare. Worse still, the shoulders are overgrown with weeds (figure 3). If a truck breaks down in this situation, the road width available for other vehicles is insufficient and safety is severely impaired.

c. Presence and state of guardrails

As the road project is being rehabilitated, the damaged guardrails have all been removed on the section of road from Ebebda to the entrance to the town of Bafoussam. New guardrails, in good condition, are therefore being installed on this section. At the level of the T3 road section, nothing has been done so far. thus, the guardrails are in very bad condition (figure 4).

d. State of road surface

Generally speaking, the study section has a fairly good road surface, thanks to the work carried out on it. However, some sections still need to be improved, as the lack of side drains has led to erosion of part of the shoulders and delamination of the pavement (figure 5).

e. Presence and state of side drains

Side drains are present where they are needed, but some of them are blocked by weeds and sediment. The lack of maintenance of these drains leads to deterioration of the road surface.

f. Presence and state of traffic signs

The national road number 4 is provided, with road signs but it is not sufficient and most of them are in bad condition; some are dirty, broken and others hidden. This is very dangerous for road users, because the aim of these signs is to warn about the situation of the road, and without this information the risks of accidents are higher.

g. Rest zone availability

Two rest zones are under construction on the road Yaounde-Bafoussam, one of which is located near the interchange of Bafia, and the other one before Ndikinéméki. In each of those rest zones, there are shops, a picnic space, toilets, a prayer room, a parking, and an administrative block. This space is intended to help road users take time to rest before getting back on the road, and to limit the risk of accidents due to tiredness at the wheel, as wasthe case for the accident on 12 December 2020 which killed 52 people and injured 21.

2. Road intersection

Out of the 20 intersections registered in this study, 4 were described as critical and their study provide an overview of the problems present in terms of layout, street vendors, waste, lighting.

a. Intersection description

All the intersections that are described as critical are T-type. One of them is outside the curve of the road (Carrefour Banekane), and it is not signaled. It is very difficult for road users to see it and to take the necessary measures to avoid an accident. Another one is on the right-hand side of the road (Ndikinemeki market), and it is not signposted either. Drivers therefore tend to accelerate at this point, which increases the risk of an accident.

b. Presence of street vendors

Street vendors are present mainly at all places where travel agency vehicles usually slow down to allow passengers to buy local products. This has a great influence on accidents between vehicles and pedestrians, as vendors do not hesitate to occupy the road to sell their products.

c. Waste accumulation

Waste accumulation near the road not only reduces the width of the road but also, it does not allow water to run off well. This can accelerate the deterioration of the road and can favorize accidents.

d. Presence and state of lighting

Among the 4 critical intersections identified, only 2 have streetlights. However, not only is the number of streetlights insufficient in both cases, but also one of these intersections [Banékané intersection (C19)] has defective streetlights (figure 2). Thus, the visibility of the road is reduced and can increase the risk of crash.

PROPOSED RECOMMENDATIONS FOR IMPROVEMENTS

Recommendationsarebased on what is present in the literature and mostly on the safe system approach and adapting them to the Cameroonian context to design forgiving road which increase safety of all road users.

1. Speed consistency

Most accidents as seen are caused by speeding. Speed has an impact on both the likelihood of a crash occurring and the severity of the outcome when crashes occur. Figure 6 provides information on change in speed for rural roads and freeways. This highlights that the more severe crash types (especially fatal crashes) increase most with an increase in speed.Speed is therefore the most important factor to control.

On the national road 4, road infrastructure is mainly composed of 2 lanes without physical separation, so it can not satisfy a very high mobility (speed above 100 km/h) for safety reasons. It would be better to have a maximum speed of 80 km/h and 30km/h where pedestrians are present, to ensure the right balance between mobility and safety.

2. Monitoring and maintenance of road surface

Regular road maintenance should be performed to guarantee safety of the road user. Also, maintenance costs and time increase with increased degree of defects. Efficiency of side drains has to be maintained by regular cleaning to ensure evacuation of rain water, thus road flooding avoided and aquaplaning risk reduced.

3. Shoulder width increase and clear zone creation

The concept of the "forgiving roadside design" includes the provision ofspace by the road side for break down vehicles. In general, this means that, when a driver commits a mistake due to unavoidable circumstances, his or her mistakes will be forgiven by the design concept. Efficiency of side drains must be maintained by regular cleaning to ensure evacuation of rainwater, thus road flooding avoided, and aquaplaning risk reduced.

4. Number of lanes and median

Head-on crashes (35.29 %) are the collision type most present on the National road 4, due to a variety of vehicle categories (trucks, buses, automobiles and motorcycles) which leads to traffic conflicts, principally between fast moving and slow moving vehicles since only 2 lanes are mostly present. (Elvik et al. 2009) demonstrated that moving from 2 lane roads to 4 lane roads with raised median reduced injury accidents by 51 %. This can be explained by the fact that on a 2x2 lane road, there exists a space for slow moving vehicles, thus reducing the conflict between vehicle categories. Also, the presence of raised medians separates opposing traffic flows; this reduces the risk of head-on crashes. So, it is recommended that the national road 4 should be converted to a 2x2 lane road with raised medians especially on the section of road that connects Yaounde and Obala because it supports both part of the N4 (Yaounde-Bafoussam) and N1 (Yaounde-Kousseri).

Audio-tactile line markings (rumble strips)are a technology which producesmall vibrations on a vehicle when it climbs on the line marking. Constructed medians (raised medians) tend to produce a greater safety benefit than painted medians, with around a 50% reduction in crashes compared to around a 15% reduction. Recent trials involving wide painted centerlines and audio-tactile markings have produced initial promising results, with reductions approaching those seen from constructed medians (Dc, 2021).

5. Maintenance of Guardrails

The benefits from installing appropriate barrier systems and ensuring that these are adequately maintained can be substantial with the benefits of up to 80 % reductions in severe crash outcomes(Dc, 2021). The state of guardrails is very bad on N4. Because of its importance, it is advisable to always take care to replace those which are broken or deformed after a shock emitted by a vehicle and put each category in the right place. For example, at the level of the various bridges which are after Ndikinimeki (where a bus ran off the bridge at full speed and caused 52 deaths) it is advisable to put there the rigid barriers at least on 10 m after the bridge to limit accident gravity.

6. Provision and maintenance of traffic sign

Signaling the presence of an intersection considerably reduces the risk of an accident. It is therefore necessary to provide it in the right place and maintain them.

7. Provision and maintenance of traffic calming

Many solutions can be used in combination to create low speed environments which provide a greater degree of safety for vulnerable road users, including pedestrians. They have a reasonably good chance of surviving when struck by vehicles at or below 30 km/h. Humps and platforms refer to raised sections of pavement, with various forms of speed humps and platforms available for different road types and speed environments.

Intersection C12 (Ndikinemeki market), which is also a periodic marketplace, is located on a straight alignment where road users tend to speed up. Thus, it is necessary to install appropriate traffic calming on both sides of the market entrance to avoid fatal collisions with pedestrian.

8. Provision and maintenance of lighting

Street lighting can provide safety benefits at midblock and intersection locations and can also improve safety for pedestrians, particularly at crossing points. Providing street lighting at intersection locations can reduce nighttime crashes by allowing the intersection features visible to both vehicular and pedestrian traffic. Installing and maintaining lighting at all intersections would go a long way to make the road safer for all users.

9. Appropriate data collection and management process

During the data collection, there were shortcomings in the availability of digitized data and also data quality. To correct these data problems, the following measures and actions can be taken:

- Develop and implement training seminars on accident data collection to collectors;
- Improve the data collection tools of gendarmery constables. Among these improvements we have: the equipment of the constables of the GPS to thus specify, with exactness, the places of accident, the necessary tools for the measurement of the slopes of the roads;
- Digitize the data collection by equipping agents with digital tablets connected to the database of accidents, so we could have updated data.

Limitation of the research

The difficulties encountered during this work were: Insufficient data due to underreporting, improper data collection on the field, and unavailability of already digitalized data. The location of the accident data in the police reports was difficult to locate during digitization as it was based on environmental features such as houses, trees and also on the distance from the office of each gendarmerie brigade that recorded the accident. This induced some errors in the data; and insufficient data related to the road infrastructure parameter at the level of accident points.

CONCLUSION

The main objective of this study was to identify the influence of road infrastructure on traffic accidents in order to propose measures to improve road safety and reduce accidents, on the Yaounde-Bafoussam road. To attain this objective, road infrastructure parameters, road crashes factors, road accident investigation techniques, crash reduction measures and documents on road safety concepts was studied.

First, a field visit was made in order to collect the geometric parameters and the general condition of this road. Then, the accident data on this axis wascollected from SED and finally a quantitative analysis of these data was made using Microsoft Excel software, by using the crash frequency and the injury severity density criteria, to obtain the accident-prone locations, which were presented using a map produced with ArcGis 10.8 software. The road data of these locations was then collected and evaluated to highlight road parameters responsible for road crash.

Accident data spanning from January 2019 to December 2020 was collected, giving a total of 102 accidents. This data was categorized and charts, presenting the accident number and severity with reference to various factors like victim's age, type of crash's vehicle, road geometry produced. A site visit of these locations permitted to find out which road parameters had an influence on road crashes on the national road 4. These are, insufficient number of lanes, inadequate median width, insufficient shoulder width, poor state of guardrails, poor state of side drains, poor state of traffic signs, inappropriate intersection layout, poor state of lighting at intersections, waste accumulation at intersection and presence of street vendors.

Knowing what is recommended, the road parameters have been studied in order to propose solutions that ensure the mobility and safety of road users: a forgiving road. Among these solutions are: the adoption of a unique speed limit except at singular points, increase number of lanes and median width, the installation of audio-tactile line marking, increase of shoulder width and creation of clear zones to ensure that, in case of a vehicle breakdown by the roadside, traffic is maintained, monitoring and maintenance of road surface, guardrails; and proper signage and lighting at intersections to maintain a good serviceability level. and also, to provide safety from a global point of view, a better accident data collection and management process is suggested.

DECLARATIONS

Conflicts of interest

The authors do not declare any conflicts of interest.

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Administrative authorization

Concerning accidents reports collection, the researcher received the authorization to collect data in all the decentralized services of the SED signed by the head of service before any data collection. The researcher also received an authorization collect road signs data from the Ministry of Transport (MINT). A copy of all those authorizationscan be available if needed.

Authors 'contributions

WOUNBA Jean Francois and NKENG George ELAMBO contributed in design of the study
ALYOUM HAOUSSAcontributed instatistical analysis and writing of the manuscript
MADOM DE TAMO Morrelle did the proofreading.
All authors have read and approved the final version of the manuscript.

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What is known about this subject

Inadequate and road infrastructures deficit are not the main causes of RTAs on national road N4, but the behavior of road users.

What your study brings back

This study brings again:

- Accidents prone locations of the national road number 4
- Main causes of RTAs on Yaounde-Bafoussam road
- Road infrastructures conditions at black spots locations on Yaounde-Bafoussam road

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Table 1. Accident data by locations

Road sections	Code (T: Road section, C: Road intersection)	Road or intersection	Length (m)	Fatal accidents	Injury accidents	PDO	Total accidents
Yaoundé-Obala	T1		8609.264	0	0	0	0
	T2		7328.457	2	1	0	3
	C1	Nkozoa		0	1	0	1
	T3		9355.658	7	3	3	13
	C2			0	2	0	2
	T4		5343.458	1	3	2	6
	C3	Carrefour Efok		0	2	0	2
	T5		999.740	0	0	0	0
Obala-Ebebda	C4	Entrée Ekabita		0	0	1	1
	T6		6647.426	2	2	0	4
	C5	Carrefour OmboloBingana		0	1	0	1
	T7		4772.906	0	0	0	0
	T8		9507.304	0	0	0	0
	T9		5960.883	0	0	0	0
	T10		5699.772	0	0	0	0
	C6	Village Nkog-Edzen		1	1	0	2
	T11		9570.355	3	0	0	3
	C7	Carrefour Tsang (Ebebda)		2	0	1	3
	T12		1088.526	0	0	0	0
Ebebda-Bafia	C8	Village Ebebda 1		0	1	1	2
	T13		7298.903	0	0	0	0
	T14		7452.491	2	2	0	4
	T15		8318.476	0	0	0	0
	T16		8852.538	1	0	1	2

Road sections	Code (T: Road section, C: Road intersection)	Road or intersection	Length (m)	Fatal accidents	Injury accidents	PDO	Total accidents
	T17		9606.252	0	1	1	2
	T18		6279.001	1	2	0	3
	C9	Bafia town (across the street from the public safety station)		0	1	1	2
Bafia-Ndikinimeki	T19		4173.853	0	1	0	1
	C10	Village Biamo		0	0	0	0
	T20		2675.737	0	0	1	1
	C11	Bape Claude		0	1	0	1
	T21		9780.744	0	0	0	0
	T22		9486.031	4	3	0	7
	T23		9098.549	1	1	0	2
	T24		7617.386	0	0	0	0
	T25		7827.006	0	0	0	0
	T26		4111.654	0	0	0	0
Ndikinimeki-Bangangté	C12	Ndikinémékimarket		1	0	1	2
	T27		6351.958	4	1	0	7
	T28		4875.459	0	0	0	0
	C13	Barriere district		1	0	0	1
	T29		3317.995	0	0	0	0
	T30		5476.544	0	0	0	0
	C14	Brigade Gendarmerie Makenene		0	1	0	1
	T31		5660.315	0	0	0	0
	C15	Carrefout Tonga		1	0	0	1
	T32		7253.509	0	1	0	1
	C16	Maham		1	0	0	1
	T33		5732.033	1	1	0	2
	C17	Bantoum 2		0	1	0	1
	T34		2581.636	0	0	0	0
	C18	Bantoum 2(entrance of the high school)		0	1	1	2
	T35		8651.030	0	0	1	1
	T36		5592.509	0	0	0	0
	C19	CarrefoutBanekane		0	3	0	3
	T37		9050.295	0	1	0	1

Road sections	Code (T: Road section, C: Road intersection)	Road or intersection	Length (m)	Fatal accidents	Injury accidents	PDO	Total accidents
Bagangté-Bandjoun	T38		6850.029	0	0	0	0
	T39		9881.185	0	0	2	2
	T40		8645.113	0	0	0	0
Bandjoun-Bafoussam	C20	Bandjoun (Entrance to the upper chieftaincy)		0	1	1	2
	T41		8887.758	0	1	1	2
	T42		7323.394	0	0	0	0

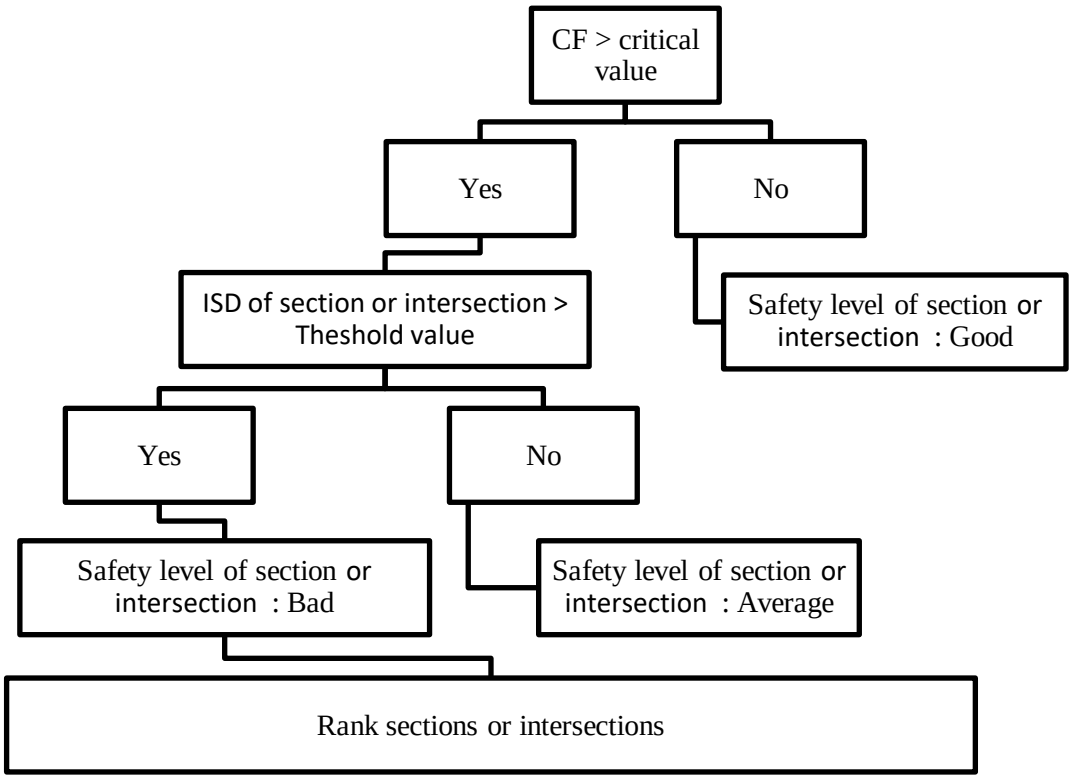

Figure 1. Flow chart for accident data analysis

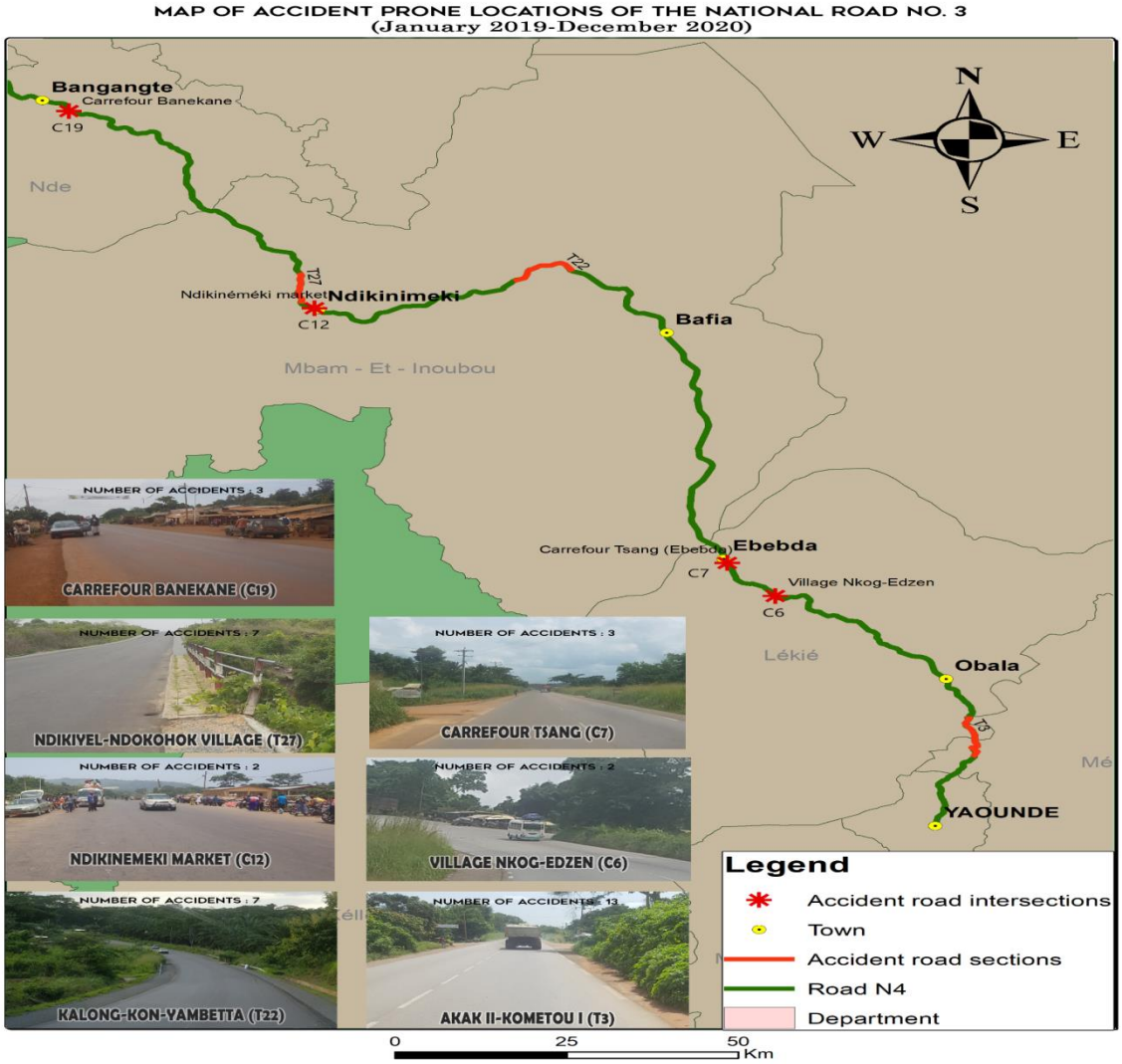

Figure 2. Map of accident-prone locations

Figure 3. shoulders overgrown by weeds

Figure 4. Guardrails in bad condition

Figure 5. State of road surface

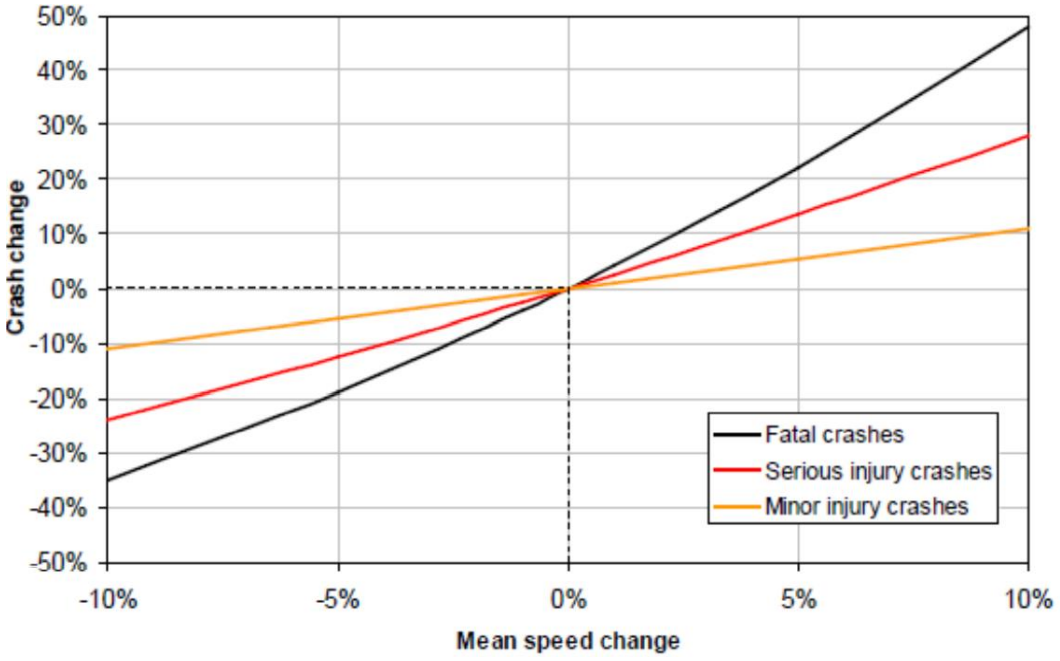

Figure 6. Relationship between change in speed and change in crash risk. (Source: Elvik 2009)

Table 2. Road geometric and environment elements of road sections

	Road Segment	*Akak II (station BESSING)-KOMETOU I*			*Kalong-Kon-Yambetta*			*Ndikiyel-Ndokohok village*		
	Segment code	*T3*			*T22*			*T27*		
No	**Geometric elements**									
1	Segment length (m)	*9355.66*			9486.03			*6400*		
2	Road width (m)	*7.3*			*7.4*			*7.4*		
3	No of lanes	*2*			*2*			*2*		
4.1	Median type	None	Raised	Painted	None	Raised	Painted	None	Raised	Painted
4.2	Median width (m)	*0.15*			*0.15*					
5	Shoulder width (m)	0-2.4			*1.5*			*1.5*		
6	Presence of clear zone	Yes	No		Yes	No		Yes	No	
7.1	Number of access points	*6*			*2*			*6*		
7.2	No of access controls	*0*			*0*			*0*		
8	No of mixed vertical grade and horizontal curve	*11*			*2*			*5*		
No	**Environment elements**									
1.1	Presence of guardrails	Yes	No		Yes	No		Yes	No	
1.2	State of guardrail	Good	Broken	discontinuous	Good	Broken	discontinuous	Good	Broken	discontinuous
2.1	State of road surface	Good	Medium	Bad	Good	Medium	Bad	Good	Medium	Bad
2.2	Type of deterioration	Cracking	Deformation	Delamination	Cracking	Deformation	Delamination	Cracking	Deformation	Delamination
3.1	Presence of side drains	Yes	No		Yes	No		Yes	No	
3.2	State of side drains	*Blocked by weeds and dirt*			*Good*			*Not finished*		
4.1	No of traffic sign							*Only for building site*		
4.2	Traffic sign legibility	Good	Hidden	Broken	Dirty	Good	Hidden	Broken	Dirty	Good	Hidden	Broken	Dirty
4.3	Type of traffic sign									

	Road Segment	*Akak II (station BESSING)-KOMETOU I*		*Kalong-Kon-Yambetta*		*Ndikiyel-Ndokohok village*	
	Segment code	*T3*		*T22*		*T27*	
5.1	Rest zone availability	Yes	No	Yes	No	Yes	No
5.2	Rest zone equipment						
6	Presence of visual clutter	Yes	No	Yes	No	Yes	No
7	Street vendors	Yes	No	Yes	No	Yes	No