

The impact of road signs on road traffic accidents : case of Yaounde, Cameroon

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Abstract:

Background: Each year in the world, Road Traffic Accidents (RTAs) are responsible for more than 1.35 million deaths and 40 times more injuries; 90% of these deaths occurs in low- and middle-income countries. Among factors that influence RTAs, road signs have been pointed out by certain authors as something to be taken into account.

Objective: The main objective of this study was to assess the impact of road signs on the occurrence of RTAs in the city of Yaounde.

Materials and method: The study used a mixed method (qualitative and quantitative) including a documentary review on road signs, a descriptive analysis of RTAs, field investigations at black spots locations, interviews with road safety specialists and policy makers and lastly surveys addressed to road users.

Results: From the descriptive analysis of accidents, it emerges that the major causes of RTAs in the city of Yaounde are speeding, poor road conditions and inadequate road signs; the latter being involved in 70.2% of accidents. The use of simple road safety indicators made it possible to identify 15 black spots in the city of Yaounde, including 11 road sections and 4 intersections. Field investigations carried out at the black spots to confirm a possible association between the occurrence of RTAs and road signs have made it possible to make a serious and alarming observation on the poor road signs conditions on these sites. The need to collect the opinions of road users on the subject involved the participation of 210 drivers, 300 pedestrians and 50 traffic police officers. From this survey, it is noted that road users believe not only that they are at risk of accidents during their daily trips but also that, inadequate road signs in the city of Yaounde have a significant impact on the occurrence of RTAs. Also, the inability of public authorities to provide and maintain road signs in order to guide road users through the numerous black spots identified is one of the main causes of RTAs in the city of Yaounde.

Conclusion: The study shows that provision and maintenance of road signs present a great opportunity that can promote safety on the Yaounde road network and help in achieving the sustainable development goals.

Keywords: road signs, Road Traffic Accidents, black spots, survey, Yaounde.

List of abbreviation

GDNS General Delegation for National Security
ISD Injury Severity Density
KIIs Key Informants Interviews
MINPW Ministry of Public Works
MINT Ministry of Transport
PDO Property Damage Only
RTAs Road Traffic Accidents

WHO World Health Organization

INTRODUCTION

For centuries and millennia, people have moved from place to place to carry out their daily activities. To make it easier to get around, people use different modes of transportation, including road, air, water, train, etc. Road transport has advantages for both nations and individuals by facilitating the movement of goods and people (WHO, 2009). It allows people to have increased access to jobs, markets, education, recreation and health care. Debebe (Debede, 2014) noted that road transport has major advantages over other means of transport due to their flexibility, which allows people to trade door to door over short distances at the most competitive prices. Developing countries have focus their research on safety studies as a result of an increase in the number of deaths due to RTAs. They are found to be among the top leading causes of deaths and injuries at various levels (Beshah et al., 2005). It is estimated that 1.35 million people die each year due to RTAs, while about 50 million people are injured and about 85% are in developing countries (World Health Organization, 2018). Theoretical explanations indicate that road traffic accidents (RTAs) constitute major challenges for the health and economic development of developing countries, in particular those of Africa (Chen, 2010). Nevertheless, a number of developing countries have been able to reduce RTAs in the last few years but Africa, Asia and Latin America continue to experience high rate of RTA and fatalities (Tiwari, 2017). The situation of RTAs is most serious in sub-Saharan Africa, where millions of lives are lost and important assets are damaged (Bhalla et al., 2014). 90% of one million deaths and several disabilities caused by RTAs per anu globally occur in low-and-middle income countries to which the sub Saharan African zone belongs (National Highway Traffic Safety Administration, 2015; WHO, 2013).

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 regardless of the environment and the vehicles (WHO, 2009). Considering over speeding as the main cause of RTAs is not always true especially in regard to developing countries where road infrastructures are poorly maintained and in some cases nonexistent (Drummond-Thompson, 1993; European Commission & Direktion Verkehr, 2008; Melo et al., 2013). Researchers have identified inadequate road infrastructures as a possible cause of RTAs in developing countries but the impact of road signs on RTAs in these countries especially African countries has not been subjected to many studies. For these countries, emphasis should be laid upon the importance of road signs.

The Vienna Convention (The United Nations, 1968) on road signs divides road signs into four types including vertical signs (traffic signs), horizontal signs (pavement markings), traffic light signs and manual signs. The most important types of signs for road engineers are pavement markings and traffic signs (Ndjoukya, 2008). Well designed and implemented, road signs will reduce accidents and facilitate traffic (Kinderytė-Poškienė & Sokolovskij, 2008). In developed countries like the United Kingdom for example, road signs have permitted to reduce RTAs by 41% (Turner, 2006) which is a very encouraging result. In the meantime, some developing countries like Mexico and Columbia, road signs have also been used to reduce RTAs (Híjar et al., 2003; Rodríguez et al., 2003). Despite the success of road signs in limiting RTAs and promoting safety, they are usually neglected in most developing countries.

In Cameroon and in Yaounde in particular, RTAs remain to be one of the critical problems of the road transport sector despite the government's efforts in developing the road infrastructure sector. More vehicles and high traffic have led to traffic congestions and road safety problems with an average of more than 10 accidents being recorded a day in the city capital, Yaounde (Zacharie, 2014). Despite this high number of accidents in the city, no studies have been subjected to evaluate the impact on road signs on RTAs in the city of Yaounde. Thus, this study is aimed at assessing the influence of road sign on the occurrence of RTAs in the city of Yaounde. So the study will have its own significance in terms of providing inputs for decision-making, policy change or new regulations, reducing the economic lost due to RTAs in the city of Yaounde.

METHODOLOGY

1. Study area

Yaounde is the capital of Cameroon and chief town of the Centre region; Yaounde belongs to the Mfoundi division of the Centre region and measures a total surface area of 183km² (18300ha) and a total population estimated at 3.8 million in 2019. The transportation system in the city consists of air, road and rail. In terms of road transport system, the most used means of traveling in Yaounde is the collective taxi despite the fact that minority of families own one or more personal cars.

2. Research design

The study utilized the qual-dominant mixed methods (qualitative and quantitative), comprising descriptive analysis of accidents, site investigations, surveys and key informant interviews (KIIs). The following chart (figure 1) summarizes the process of research structure.

3. Research strategy

In the following sections, the justification of choice of strategies and explanation of how they both operate and inter-operate in the research is done. The research strategy of this paper is described by the following steps:

Collection of accident reports: this part consisted of collecting reports of accidents that have occurred in the city of Yaounde in recent years, starting from the most recent to the oldest accidents. The results of this stage allowed us not only to make a descriptive analysis of accidents over the collection period, but also to identify black spots in the city of Yaounde.

Black spots identifications: this part consisted on the basis of the accidents collected above to identify black spots in the city of Yaounde by applying road safety criteria and to establish a map of black spots. The black spots identified constituted a preliminary step in order to inspect the road signs in the city of Yaounde.

Sites investigation at black spots locations: the site investigation consisted in making an inspection of road signs (traffic signs and pavement markings) at the black spots locations by taking their parameters (size, colors, message etc ...). To try to ensure consistency, the same surveyor inspected and evaluated the panels at all sites during the day and transferred the assessments into the field survey form. The results of this section allowed us to get an idea of the state of road signs in the city of Yaounde. The effects of the current road signs in the city on road users have therefore been undertaken.

Survey addressed to road users: the effects of road signs on road users were therefore assessed by means of questionnaires distributed to drivers, pedestrians and traffic police officers.

4. Procedure

The detailed explanation of the four steps listed in the research strategy will be the main goal of this section.

i. Collection of accident reports :

- Sorting of accidents reports occurring only in the city of Yaounde
- Establishment of excel sheets for taking the characteristics of each accident. Three excel sheets are thus established: a first for the circumstances of the accident, a second for the victims involved and a last for the vehicles involved in the accident.
- Coding and export to IBM SPSS v20 software
- Descriptive analysis of accidents

ii. Black spots identifications:

- Method selection: the identification method chosen is that using the simple safety indicators, namely the accident frequency, the Injury Severity Density (ISD) and the accident rate. The latter has not been used because, on the basis of several studies, does not give satisfactory results. A combination of two indicators (accident frequency and ISD) was therefore adopted.
- Threshold values: with respect to a study carried out in Canada (Soto-Rodriguez, 2014) , the accident frequency of each site was compared to threshold frequencies of 4 accidents for intersections and 4 accidents per 0.5 km for road sections. If the frequency of a site is greater than the threshold value, the site

is considered potentially problematic and tested using the second criteria namely ISD. The latter adopted for developing countries, consider all types of accident severity levels named as: Property Damage Only (PDO), light injury, serious injury and fatal. ISD is calculated using the following equation (Ragnøy et al., 2002).

$$\text{ISD} = \text{Weighted accident frequency} / \text{Road section length (km)}$$

The Weighted accident frequency can be gotten using weightage points developed for a low-income country (Malaysia) where fatal, serious injury, slight injury and PDO accidents have weightage point 6, 4, 2 and 1 respectively (Eskindir, 2019).

However, the use of these weightage points was inappropriate for our study due to the lack of distinction between slight and serious injuries in the accidents reports data. Thus, a point weight of 3 was assumed for accidents with injuries (which is the average point weight of serious and slight injuries). In this case, the resulting equation used is:

$$\text{ISD} = \frac{6 * \text{Fatal} + 3 * \text{Injury} + \text{PDO}}{\text{Segment length (km)}}$$

The black spots are then obtained by comparing the ISD values of each potentially problematic site with a threshold value proposed by Eskindir (Eskindir, 2019):

Threshold-value = max (x,m) where x is the average ISD value and m the median ISD value.

Sites with ISD values greater than the threshold value are considered black spots locations and selected for further analysis.

- Loading of each accident location on the Yaounde city map using ArcGis v10.4.1 software
- Segmentation of the road network of the city of Yaounde into road sections and intersections having recorded at least 2 accidents over the collection period.
- Representation of black spots having satisfied the two criteria defined above by making a distinction between road sections and intersections.
- Printing of black spots map of the city of Yaounde

iii. Sites investigation at black spots locations

- Design of the data transfer sheet

Taking the characteristics of all road signs (horizontal and vertical). For each sign in the survey, characteristics including sign type, age, retro-reflectivity class, obstruction, size, colour, symbol, lateral and longitudinal offsets, orientation, height and condition were recorded.

iv. Questionnaire and interview addressed to road users and KIIs respectively.

- Design of input mask by using CS PRO v7.3.
- Sampling method: the study populations are drivers, pedestrians and traffic police officers who are located in 7 sub-cities of Yaounde. In this research, were used probabilistic sampling techniques which include proportional sampling used to select pedestrians and taxi drivers, and stratified sampling used to select traffic police officers in accordance to the number of blackspots identified. Non-probabilistic sampling techniques were also applied among which judgment sampling was used to complete taxi drivers and pedestrian's selection, and simple random sampling to complete traffic officers selection.
- Key Informants Interviews (KIIs): This part consisted of interview with government officers at MINPW and MINT, two officials from each ministry department, and interview with road safety experts from GDNS and SED. Each key informant was interviewed separately on a different day or time following a scheduled appointment, each interview took between 25 to 35 minutes, and it was conducted by using a semi-directive interview guide. Additional probing questions were asked. One of the aims of this study is to produce a document to inform decision-makers about the state of road signs in the city of Yaounde in order to bring about the improvements necessary for the safe use of the road by users.

Data analysis

The road accident data obtained from the GDNS statistical service were classified into three nature of accidents (fatal, injured and PDO). The data was saved in a computer using the CS Pro version 7.3 software. The data were analyzed by descriptive and analytic statistics methods using SPSS (Statistical Package of Social Sciences) software, version 20.0. The quantitative variables were expressed on average with their standard deviation, the median and interquartile range was used when the distributions did not follow a normal distribution. The qualitative variables were expressed as a percentage. The relevant data of the identified black spots locations are organized and subjected to mapping using GIS tool named ArcGis v10.4.1. Results of field observations (road signs inspection, interviews etc.) Were saving in the computer using Microsoft Excel 2016 and then analysed using the thematic content analysis method.

RESULTS

1. Characteristic of Road Traffic Accidents (RTAs) on the Yaounde road network (from October 2018 to September 2019)

From accidents reports collected, we counted 483 accidents causing 1021 identified victims of which 103 are females (9.6 %) and 918 (85.6 %) are males. Out of the 483 accidents recorded: 287 (59.42%) were PDOs (Table I); 201 (41.6%) occurred outside the intersection (Table I); human causes were involved in 476 (98.55%) accidents, as long as the traffic signal deficit was involved in 339 (70.2%) accidents, at least two in tree accidents (Table I).

The distribution of accidents according to their typology and the occurrence place constituted a solid foundation in the identification of black spots in the city of Yaounde.

2. Black spots identified

For accident analysis purpose, the road network was divided; 34 road sections of different length and 15 intersections were eligible. The black spots identified (11 road sections and 4 intersections) with respect to both accident frequency and ISD are presented below (Table II), for a calculated threshold value respectively of 8 and 20 for road sections, 4 and 2 for intersections.

The identified black spots locations were mapping using GIS tools by separating road sections and intersections. We came out with the accident's prone locations map of the city of Yaounde presented as a supplementary file to this paper, where all the 15 black spots are represented with 2D and 3D zoom for each site. Site investigations could be done at those specific sites identified to have the conditions of road signs.

3. Road signs condition at black spots locations

Field investigations were carried out on the 15 black spots identified in order to assess the state of the road signs on these sections. The study investigated a total 4.904 km length of the Yaounde road network. The road under study encompasses varied geometrical and environmental conditions. We went through all these sites and got out of the survey vehicle to carefully inspect each sign and road marking.

A total of 43 traffic signs were inspected and 124 other signs were recorded as "absent". Out of the 43 traffic signs inspected, 30 (69.77%) where PW signs type (Table III); 19 (44.19) where class 1 of retro-reflectivity and only 11 were satisfactory (Table III). In regard to pavement markings investigated on the same sites, it was found that majority was missing.

The results of site investigation showed that there was large absence of traffic signs at the order of 63.27% (Table III) and numerous omissions of pavement markings. It remains to take the opinions of road users, to know if this deficit has an impact on their daily travel and therefore on the occurrence of RTAs in the city.

4. Influence of road signs condition on RTAs in the city of Yaounde according to road users

In addition to the secondary data source, the researcher distributed questionnaire to 560 inhabitants of the city of Yaounde (300 pedestrians, 210 drivers and 50 traffic police officers) to know the status of traffic accidents in the capital and the possible influence that road signs can have on road users and possibly on RTAs. From the questionnaire addressed to pedestrians and Traffic police officers, it emerged that over speed, poor road condition and inadequate road signs are the major's causes of RTAs in the city of Yaounde as can be seen in Table IV. 151 (50.33) of pedestrians and 26 (52%) of traffic police officers think that road signs deficit have an moderate and severe influence on the occurrence of RTAs respectively in the city (Table IV). About the condition of road signs in the city, 197 (93.81%) drivers thinks that road signs in the city are old (Table V); regarding the positioning of the signs, 163 (77.62%) drivers think that traffic signs are too far removed from the road (Table V).

5. DISCUSSION

The purpose of this study was to assess the impact of road signs on the occurrence of RTAs in the city of Yaounde. Among the factors that affect the precision of any study, the availability and reliability of the information it employs is very important. This study mainly uses the information collected from GDNS statistical office for one year accident records (from October 2018 to September 2019). Therefore, the study is restricted to assess the case of the city of Yaounde along that line. The study was based not only on a structured questionnaires addressed to some pedestrians, drivers and traffic police officers but also on interview addressed to some Keys Informants. Also, traffic police officers were chosen among the respondent because they are concerned with the issue and comfortable with the researcher, especially with regard to availability, knowledge about the issue, and experience aspects.

In the city of Yaounde the type of accidents is predominantly of three types: PDO, fatal and injured accident with PDO dominating and fatal accident being the least. This result is consistent with that obtained by Eskindir (2019) during his study carried out on the impact of road geometry on RTAs in Addis Abeba (Ethiopia). The PDO domination could be due to the dense traffic in the city which inhibit drivers from driving at high speeds thus most accidents are not only head on collisions due to traffic congestion but also due to the lack or violation of road signs. Although most accidents are PDO, it is observed that fatal accidents still occur and being minor as it is, it draws attention because life is priceless.

The RTAs observed in the city were due to causes grouped into three main categories of which we have human related causes, vehicle related causes and road environment related causes. Human related causes came out to be the predominant cause because it was involved in 89.74% of accidents that occurred during the period of data collection. Responses brought by road users questioned will not demonstrate the contrary because from the major causes reported by the latter, the highest frequency of response was attributed to high speed which is a human cause. This affirmation can be supported by the Transport Project Manager in the Ministry of Public Works who was interviewed as a key informant affirmed that: "the majority of the RTAs that occur in the city of Yaounde is due to the irresponsibility of drivers which is a consequence of poverty most of the time". Road infrastructure is equally highlighted because concerning the main issue of road sign, it was observed that road sign deficit was involved in 70.2% of the reported accidents. These results obtained are consistent with those obtained by Sango (Sango, 2014) in Mali where the lack of road signs was involved in 57.8% of injury accidents. Furthermore, this result was confirmed by 86% of the traffic police officers interviewed whose responses were in favor of poor road condition and inadequate of road signs as top leading cause of RTA in the city of Yaounde.

On the basis of these preliminary results, it can be seen that road signs intervenes from near or from far in the occurrence of RTAs in the city of Yaounde. In order to confirm a possible association between road signs and RTAs, site investigations were conducted at black spots locations identified based on the typology of accidents and some criteria defined in the methodology of the present paper and presented in the results. Among the three simple safety indicators, a combination of two of them, accidents frequency and ISD were used to identified blackspots. Bayesian approaches which are more precise according to Rodriguez (Soto-Rodriguez, 2014) could not be used in this study because they requires lot of supplementary data that the researcher could not have at the time were the study was conducted. Based on the comparison study done by Rodriguez (Soto-Rodriguez, 2014), the black spots identified in the case of this study is not so far from those that could be obtain by using the Bayesian approach to identify them..

Site investigation at black spots locations identified revealed a considerable deficit of road signs at these sites. Only 43 traffic signs were installed and investigated against 124 traffic signs reported as absent. Deficit could be due to vandalism and somehow corruption as reported by an official at the MINT who lament that : “ if the funds allocated for road construction and road maintenance was properly used, deficit of traffic signs in a city like Yaounde wouldn't have been an issue to discuss about”. Although a minority of road sign was observed on the investigated sites, those present are not in an acceptable state because on the 43 traffic signs present and investigated at the blackspots, only 11 (25.58%) were found in an acceptable state of service. Responses brought by drivers interviewed will not demonstrate the contrary like 93.81% of drivers found that traffic signs in the city are all old and most of the times are obstructed by dirt or posters. They go further questioning the position of certain traffic signs in the city because according to them traffic signs are too far removed from the road and most of the times the distance between these traffic signs and the hazard is too short. A credit can be granted for these points in the measure where “the road signs standard in Cameroon are not always consulted during their installation by the traffic Management Committee of the Urban council” as confirmed by the Commander of the Regional Grouping of Public Roads for the Centre Region.

With regard to the discoveries made on the state of road signs at blackspot locations, it may be wise to think that traffic sign can have an influence on the occurrence of RTAs in the city of Yaounde as can be illustrated by the responses delivered by pedestrians. 82.67% cross the road at any point and 50.33% affirm that road signs have a moderate influence on RTAs meanwhile 95% of traffic police officers affirm that the influence is rather severe.

Limitation of the research:

Reason for studying only one year accident report was time constraint since all data were essentially on hard copy, so needed lot of time which was not available to digitalize these data. Also, the absence of information relating to some RTAs in terms of number, type, distribution, traffic flow and other related factors, made this study difficult. Concerning drivers that had to answer the questionnaire, the researcher chose only taxi drivers because of their facility of access at petrol stations located near those sites.

CONCLUSION

The main objective of this research was to assess the influence of road signs on the occurrence of RTAs in the city of Yaounde. On site survey coupled with studies carried out on the basis of accident reports collected between October 2018 and September 2019 revealed that the inadequate and absence of road signs observed in the city of Yaounde are among the major causes of RTAs.

In general, road signs in Cameroon are overlooked as an important road infrastructure that guides road users at multiple accident black spots. The neglect of road signs in the city of Yaounde is not unrelated to the central role of the Cameroonian government in the supply and maintenance of road infrastructure. As a result, political corruption becomes a major obstacle to the provision and maintenance of road signs. Traffic signs and road markings are therefore either absent, inadequate or abandoned. These signs can neither inform nor warn road users against road dangers, thus leaving a feeling of insecurity among road users, in particular drivers and pedestrians.

However, inadequate and deficit of road signs were not the only factors that lead to RTAs in the city but Li, Z. et al. (Li et al., 2010) have shown that the implementation of road signs will reduce PDO, fatal accident and injury accidents to about 10%, 9.5% and 9.8% respectively. The study revealed that drivers were responsible for almost 75% of the accidents. Inattention, over speed, dangerous overtaking and failure to give way for pedestrians and observed errors of drivers were also reported as being causes of RTAs. The surveys also revealed that people in the city of Yaounde pay little attention to traffic because of little experience and knowledge on traffic regulation, lack of awareness about how to act safely in the automobile traffic system.

Thus it can be concluded from this study that road signs could be overseen as a cause of RTAs but can't be considered as the leading cause, instead human factors like over speeding, inattention etc. as illustrated.

We must therefore not focus solely on road signs in the process of reducing the risk of accidents in the city of Yaounde but must be coupled with road safety education provided to all sections of the community and in this process; this paper presents a fertile context for the government of Cameroon.

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 General Delegation for National Security (GDNS) 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 authorizations can be available if needed.

Authors 'contributions

WOUNBA Jean Francois and NKENG George ELAMBO contributed in design of the study
BWEMBA Charles contributed in critical reading
TOKAM TINGANG Ulrich Cabrel contributed in statistical analysis and writing of the manuscript
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 sign deficit are not the main causes of RTAs in the city of Yaounde, but the behaviour of road users.

What your study brings back

This study brings again:

- Accidents prone locations of the city of Yaounde
- Main causes of RTAs in the city of Yaounde
- Road signs conditions at black spots locations in the city of Yaounde

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Table I : Characteristics of RTAs on the Yaounde road network from 2018 to 2019

Variables		Number	%
Typology of RTAs*			
	PDO**	287	59.42
	Injured	149	30.85
	Fatal	47	9.73
	Total	483	100
Relation of RTAs with intersection			
	In intersection	183	37.9
	Outside intersection	201	41.6
	At railroad Crossing	3	0.6
	Not specified	96	19.9
	Total	483	100
Presumed causes of RTAs			
	Human	476	98.55
	Vehicle	6	1.24
	Road infrastructure	53	10.97
Presence of Road signs			
	Present	77	15.9
	Absent	339	70.2
	Not specified	67	13.9
	Total	483	100
Lightning condition			
	Night with Public lighting on	39	5.59
	Night without public lighting	70	10.2
	Night with public lighting off	16	3.95

	Twilight or dawn	33	11.51
	Full day	312	64.8
	Not specified	13	3.95
	Total	483	100

* RTAs: Road Traffic Accidents

** PDO: Property Damage Only

Table II: Black spots identified in the city of Yaounde for the year 2019

Black Sport Identified according to both criteria : Road Sections								
				Accident number				
N o	Cod e	Road Section	Length (m)	PDO*	Injury	Fatal	Frequency	ISD*
1	T1	Descente belle-mère – Anguissa	92	2	0	0	22	22
2	T2	Montée Zoe	90	2	0	0	23	23
3	T3	Carrefour Bastos – Laboratoire Meka	392	5	1	0	15	20
4	T5	Rue Tamtam	310	2	2	0	15	29
5	T6	Marché huitième	120	3	0	0	25	25
6	T9	Carrefour Ekounou – Carrefour Ekié	452	3	0	1	9	20
7	T10	Carrefour Mvog Mbi – Coron	419	5	3	0	19	33
8	T12	Cimetière Ngousso – Total Ngousso	766	9	1	1	14	23
9	T15	Descente Etoa Meki	306	1	3	0	13	33
10	T19	Entrée Emia – Gendarmerie Nationale	788	6	4	0	13	23
11	T27	Carrefour Nkomo – Awae Escalier	1169	4	2	3	8	24

Black Sport Identified according to both criteria : Intersections								
N o	Cod e	Intersections	Length (m)	PDO	Injury	Fatal	Frequency	ISD
1	C2	Rond-Point Express		3	0	1	4	2.25
2	C9	Carrefour Texaco Omnisport		4	0	1	5	2
3	C11	Premier échangeur Ahala		2	1	2	5	3.4

* PDO: Property Damage Only

** ISD: Injury Severity Density

Table III: Road signs condition at black spots locations (2019)

Traffic signs			
Variables		Number	%
Type of signs			
	RG*	12	27.91
	PW**	30	69.77
	IS***	01	2.33
	Total	43	100
Retro-reflectivity class			
	Class 1	19	44.19
	Class 2	12	27.91
	Class 3	06	13.95
	Others	06	13.95
	Total	43	100
Overall state of road signs			
	Satisfactory	11	5.61
	Non satisfactory	32	31.12
		<i>Too small</i>	5
		<i>Wrong place</i>	15
		<i>Hidden</i>	11
		<i>Wrong configuration</i>	9
		<i>Need replacing</i>	21
	Absent	124	63.27
	Total	167	100
Pavement markings			

Missing type	Dimension (mean±SD)
Longitudinal centre line	4,522 ± 0.98m
Longitudinal edge line	10,155 ± 0.96m
Specific road markings (STOP line, give-way line, parking lot etc...)	445 ± 0.63m ²
Zebra crossing	954 ± 0.71m ²

* RG: Regulatory signs, ** PW: Permanent Warning signs, ***IS: Informative Signs

Table IV: Pedestrians and Traffic police officers responses (2019)

Pedestrians responses			
Variables		Number	%
What is the level of influence of inadequate and road signs deficit on RTAs* ?			
Response	Slight	63	21.00
	Moderate	151	50.33
	Severe	83	27.67
	Indifferent	03	1.00
Total		300	100
Do you fully understand road signs when moving in the street ?			
Response	Yes	21	7.0
	No	130	43.3
	Not always	149	49.7
Total		300	100
At which point do you usually cross the road ?			
Response	At any point	248	82.67
	At traffic light	31	10.33
	At zebra crossings	21	7.00
Total		300	100
In your opinion, what are the major causes of RTAs* in the city?			
Response	Over speed	279	93.00
	Poor road condition	222	74.00
	Not giving priority to pedestrians	138	46.00

Traffic police Officers responses			
What is the level of influence of inadequate and road signs deficit on RTAs* ?			
Response	Slight	09	18.00
	Moderate	11	22.00
	Severe	26	52.00
	Indifferent	04	8.00
	Total	50	100
In your opinion, what are the major causes of RTAs* in the city ?			
Response	Over speed	47	94.00
	Poor road condition	46	92.00
	Inadequate and road signs deficit	43	86.00

* RTAs: Road Traffic Accidents

Table V : Drivers responses (2019)

Variable		Number	%
In your opinion, in which conditions are road signs in the city ?			
Responses	Traffic signs are old	197	93.81
	Traffic signs are vandalized	70	33.33
	Traffic signs are not retro-reflective	167	79.52
	The letterings on traffic signs are very tiny	27	12.86
	Traffic signs are obstructed by billboards	33	15.71
	Face of traffic signs are covered by vegetation	21	10.00
	Face of traffic signs are covered by posters	141	67.14
	Face of traffic signs are obscured by dirt	182	86.67
	Road markings are non-existent	61	29.05
	Road markings are not visible at night	154	73.33
	Road markings are not visible during day time	128	60.95
	The lane separation lines are not visible	61	29.05
	Zebra crossings are not visible	67	31.90
Others	04	1.90	
What do you think about road signs position in the city ?			

Responses	Traffic signs are difficult to be read while driving	177	84.29
	Traffic signs are complicated and confusing	30	14.29
	Traffic signs are too far removed from the road	163	77.62
	Traffic signs impede the movement of vehicle	19	9.05
	The elevation of traffic signs is very high	11	5.24
	The elevation of traffic signs is very low	11	5.24
	Traffic signs give wrong warnings	11	5.24
	Most right bends are warned as left bends	08	3.81
	Distance between traffic signs and the hazard is very short	137	65.24
	The drawdown arrows often mislead us	39	18.57
	The lines that allow or forbid overtaking are not visible	83	39.52
	Others	01	0.48

