iRAP Assessment and Countermeasure Selection for Safer Routes to Schools in the City of Yaoundé

T. L. NDINGWAN & J. F. WOUNBA
Department of Civil Engineering, Ecole Nationale Supérieure des Travaux Publics
Yaoundé, Cameroon
tevoh@live.com, jfwounba@gmail.com
S. K. FONDZENYUY
Centre of Research for Transport and Logistics, Sapienza University of Rome, Italy
stephenkome.fondzenyuy@uniroma1.it

ABSTRACT

Road traffic injuries of children on their way to school have been on a rise, especially in low- and middle-income countries. A series of interventions have been demonstrated to reduce injury and mortality (or morbidity), as well as change of behaviour of parents, children and communities and thus reducing the risk of fatality and serious injury. This study aimed to identify and test interventions and countermeasures that reduce the risk of Fatalities or serious Injuries (FSI) on Routes to Schools by applying the iRAP methodology. The method implemented in this research is the use of the iRAP classification of roads and the Star Ratings for Schools (SR4S) to improve road use. Low-cost methods such as the use of Mapillary and Google Maps was employed to extract geometry data, and the iRAP methodologies (road coding and analysis) were applied using the SR4D and ViDA tools for a full assessment of selected roads. Two scenarios (Scenario 1: baseline (existing road) and Scenario 2: Design (existing road with countermeasures)) were set in the study to understand the effect of countermeasures in promoting safer routes to school. The results show that the implementation of the countermeasures will lead to a reduction in 88.2% of total FSI, and 96.3% in pedestrian fatalities, hence promoting safe routes to school. The roads with designs achieved 4 and 5 stars which are in line with the sustainable development goals (SDG 3) and the UN Decade for Road Safety Plan which advocates that roads be rated at 3 stars or better. The countermeasures proposed are made available such that policymakers and road authorities can prioritize resources in the most relevant areas when developing Safer Road Investment Plans, with the encouragement of 30km/h speed zones.

Keywords: Road Safety, Star Ratings to Schools, Safer Routes to Schools, iRAP, Best Practices

1. INTRODUCTION

Road transport is the most popular mode of transport in use all around the world. Each year 1.3 million people die and a further 50 million are injured or permanently disabled in road crashes[1]. Each day, about 3500 people are killed in road crashes around the world and thousands more suffer life-changing injuries[2]. More than 500 children are killed every day as a result of road traffic collisions, and tens of thousands are injured, often suffering lifelong disabilities [3]. The devastating impacts of road travel affect the whole economy[4]. Daily, a large number of children are killed while they're carrying out their various activities. This larger number of school children deaths is the equivalent of two large secondary schools being emptied of children every day. [5]. iRAP is an international organisation that targets high-risk roads where large numbers are being KSI and identifies affordable safety engineering programs that would reduce FSI. Star Rating for Schools (SR4S) is an iRAP tool that measures and communicates the risks school children are likely to face on their way to school. [6]. Given that thousands of lives are lost around the world and also in our community because of road accidents, a look at how these accidents occur and how they can be reduced is important especially for the safety of children commuting to and from school. This study looks at the various issues with the roads in the City of Yaoundé and proposes the various countermeasures that can be implemented to make them safer and reduce the rate of FSI. The application of the proposed countermeasures will provide safer movements along roads in Yaoundé and reduce the overall number of road accidents and FSI.

2. LITERATURE REVIEW

The problem of unsafe roads has been around for several decades. Various researchers have studied its causes and effects and also methods of improving road safety and reducing the number of road traffic accidents. Amongst these solutions, is that of the award-winning internal organisation, iRAP, whose methodology has been tremendously efficient in curbing road accidents and the number of FSI worldwide.

2.1. Road Safety

Road traffic safety refers to the methods and measures used to reduce the risk of a road user being killed or seriously injured [7]. Typical road users include pedestrians, cyclists, motorists, vehicle passengers, and passengers of on-road public transport, mainly buses and trams. Road traffic injuries are the leading cause of death for children and young adults aged 5-29 years [8]. The economic cost of road crashes and injuries is estimated to be 1-3% of the gross national product (GNP) [9].

Growing vehicle ownership and rapid urbanization in various parts of Africa have increased the incidence of road crashes. Despite being the least motorized region, Africa has an estimated road accident fatality of 26.6 per 100 000 people, which is the highest rate in the world [10]. In urban areas, most accidents occur on straight paved roads which facilitate speeding, have high traffic volumes than the designed amount, a high amount of pedestrians and motorists that share the same road space with vehicles and a high proportion of young inexperienced drivers.[11][8] The number of motorised two-wheelers as a form of transport has increased in developing countries over the years and has been a major issue in road safety. [12]

According to the World Bank Global Road Safety Facility country profile for Cameroon, 64% of road crash fatalities in Cameroon affect the economically productive age groups of 15 – 64 years[13]. Cameroon records an average of 16,583 road accidents each year, killing more than 1,000 people, according to official figures, and over 6000 according to World Health Organization estimates[14]. The WHO estimates that 30.1 fatalities occur in every 100 000 people in Cameroon[13] which is higher than the regional average of 26.6[10]. The main findings of the Cameroon Road Safety Performance Review (RSPR) presented in a workshop in August 2018 in Yaoundé showed that the economic losses associated with road accidents are estimated at 100 billion CFA Francs per year (1% of GDP)[14]

Methods to implement road safety interventions are usually uncoordinated and lack evidence. The Safe Systems Approach is a road safety concept which is based on the fact that no FSIs are acceptable as people move through the transport system [15]. The Safe System Approach focuses on four (4) critical factors (safe roads, safe vehicles, safe users and safe speeds) and implements six(6) pillars of action to reduce FSI[15]. Cameroon has a national speed limit of 60 km/h for urban roads [13] which is higher than the recommended safe systems approach speed limit of 30km/h[15]. Vertical deflections are the major speed calming measures that are implemented on Cameroonian roads comprising mainly of speed bumps, raised pedestrian crossing and variation in the road surface[13].

2.2. iRAP

The International Road Assessment Program (iRAP) measures the safety of roads using international protocols that can usually be reproduced and applied in all countries around the world. iRAP achieves most of its objectives by the use of road assessment programmes. Road assessment programs are instruments of change providing road and highway decision-makers (political leaders, policymakers, and road builders) with the social, economic and engineering resources needed to transform and improve road networks. iRAP programmes and projects have now been undertaken by partners in more than 100 countries worldwide with 1.6 million km of Crash Risk Mapping and 1.4 million km of Star Rating assessments of existing roads and designs have now been completed.[16]
iRAP and its partners have developed a suite of tools that use the iRAP methodology to support infrastructure safety management globally and locally[17]. These tools can be used at all the six (6) stages of a road's lifecycle: Planning, Early design, Detailed design, Building, Open to traffic, and Maintaining and operating. The iRAP methodology describes the Star Ratings and Safer Roads Investment Plan methodologies[18] in several fact sheets. This methodology explains the iRAP approach completely and detailly and also includes formulas and the various road attributes.
Using risk maps, performance tracking and Star Ratings, the dangers in an area, the safety risks over time and a measure of the likely occurrence of a crash are obtained.

2.3. Safer Routes to Schools

Safe Routes to School (SRTS) is an approach that promotes walking and bicycling to school through infrastructure improvements, laws and regulations enforcement, road safety tools, safety education, and incentives to encourage walking and bicycling to school[19]. Safer Routes to School programmes use education, traffic law enforcement and engineering changes to promote and secure children commuting to school [20]. Alarming traffic speeds around schools frequently and significantly exceed internationally recommended school zones' speed limits. Vulnerable road users account for more than half of the global road crash fatalities[8]. Road crash injuries and fatalities can be reduced by developing a safer road environment around schools and establishing a national policy and legal framework for the creation of school zones to protect children and other vulnerable road users.[21][22]
Star Ratings for Schools (SR4S) is a tool for measuring, managing and communicating the risks children are exposed to on their daily journey to school. The Star Ratings for Schools programme (SR4S) has been continuously growing with an additional 43 schools improved and $ 123 824 invested in 2021. This brings the total amount of safer schools to 200 and over $ 2.5 million invested. About 100 upgrades have been star rated with an average star rating of 2.73 before improvements and 4.36 after improvements.[23]
The effects of having unsafe roads cause human and material damages that are very expensive[24]. Around the world, the high number of daily tragedies is a call for concern. The situation of unsafe roads is worse for countries with growing economies because of increased motorization, inefficient systems and agencies involved in regulations amongst others[14]. Risk Maps and Star Ratings are tools used to quantify the risk road users are exposed to as they journey along the roads. Safer Routes to Schools use risk maps, star ratings and performance tracking to preserve the lives of children going to school by understanding the risks and insecurities along their travel and proposing and implementing safer systems for these school children.

3. METHODOLOGY

This methodology explains in detail the research procedure used to achieve the objectives. This involves the study of the research methods and the logical and systematic solution to the research problem. The accident data made up of accidents recorded in the seven (7) subdivisions in Yaoundé, was collected from the General Delegation of National Security (DGSN). The data for the accidents that occurred in Yaoundé from October 2018 to September 2019 was collected. In total, 483 different accident cases were recorded, and all were used for the analysis.

The collected accident data were georeferenced to produce risk maps. The identification and georeferencing of the high-risk road sections were done with the use of mapping software (google maps). Google maps were further used to identify Area type and land use data for key points of interest (primary schools, secondary schools and universities). Field study and previous knowledge on the distribution of schools around Yaoundé were used to complement data on the points of interest where a greater number of schools and a high student population are found. With the observation of the risk map and points of interest, the road segment from Carrefour EMIA to Monument de la Reunification (1.6km) serves 5 schools (the most important being the University of Yaoundé 1, lycée Le Clerc (one of the most populated secondary school in Yaoundé). A high student population is therefore found in this area.

A general recognition of the site and site visits (Monday to Sunday) was conducted to observe and record traffic flow characteristics of the road segment to be analysed. Through visual examination and counts, data on traffic flow including data on pedestrian, and bicycle flows was recorded for all seven days and peak values were considered. The values were recorded during peak hours (in the morning (6:30 to 8;30 am) and evening (2 pm to 4 pm) when students are on their way or back from school. The traffic flow data was compared to already available data on AADT and the maximum values were used for road section analysis. The national speed limit data (60km/h) was used for the analysis and it was assumed the operating speed (85th percentile speed) to be 5km/h greater than the speed limit as many studies have confirmed operating speeds to be always greater than speed limits[25][26]

Pictures and video recordings of the road section were taken to provide additional information for further analysis. The geometry data of the road segment was recorded by using the tools Mapillary and GoogleMaps and the data was coded in the iRAP VIDA software which is available for free.

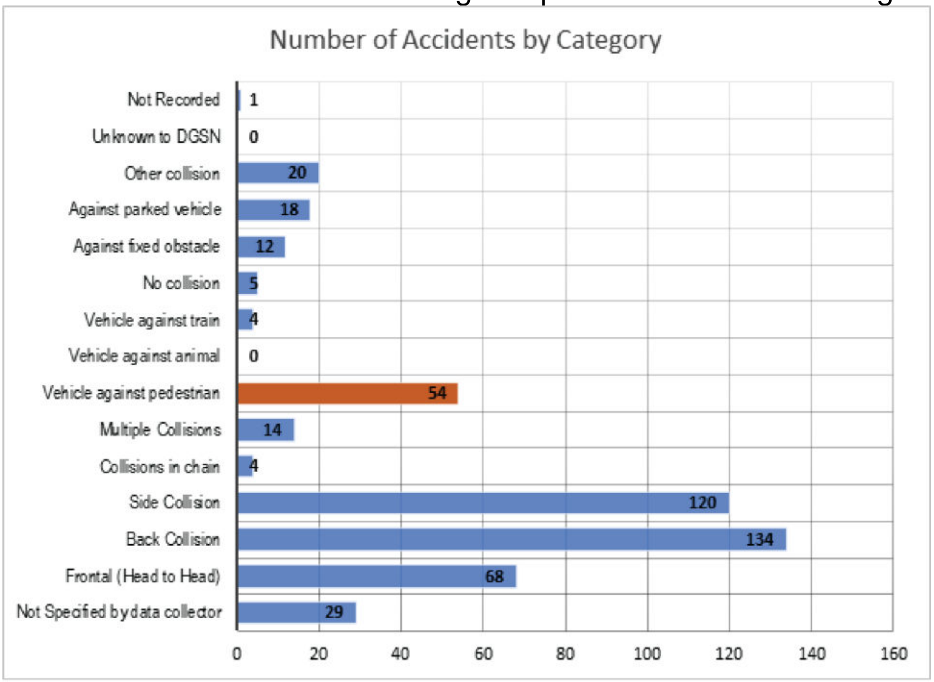
The iRAP methodology used in this study presents the possibility of a safety assessment that the users have within the road networks. The core idea of the iRAP methodology is the assessment or rating by stars using Star Rating Scores and assigning stars from 1 to 5 depending on the level of risk to which the road user is exposed. The data collected was analysed and presented as such: (i) analysis of the road accident data to understand the variations and patterns in the accidents, (ii) selection of a high-risk road section and assessment to obtain Star Rating Scores (SRS); and (iii) simulating the implementation of countermeasures and performing an assessment to obtain improved SRS.

4. RESULTS

4.1. Characteristics of Road Traffic Accidents in Yaoundé

The analysis of the road accidents showed that according to time, 75% of road accidents occurred in the months of January to May 2019, the days of the week with the highest number of accidents was Friday and the majority of the accidents occurred during the period of 10:00 am and 5:00 pm.

According to the nature of the accidents, we classified in three (3) categories: deadly, material damage, bodily damage. The majority of the accidents (61%) had material damage and a total of 12.6% of accidents were deadly. Analysis of the deadly accidents showed that out of the 483 deadly accidents, 5.6% included deaths, 4.6% included serious injury and 2.3% involved deaths and serious injury.
Collision types of the accidents were analysed and the results show that the majority of the accidents (27.74%) involved a vehicle hitting another from behind, followed by a vehicle hitting another vehicle at the side (24.84%). The accidents in which pedestrians were involved made up a total of 11.18%. Also, 9.31% of the accidents involved the loss of at least 1 human life. The age group classification of the accidents shows that adults aged 25 to 64 made up 73% of the individuals involved in the accidents and kids and young adults aged 6 to 24, made up 6% of the accidents.
According to the features of the road, 38.7% of accidents occurred on roads with widths between 5 and 10 m, 60.5% of the accidents occurred on two-way roads, and 70% of the accidents occurred on roads with no traffic signals present. See charts in figure 1.



(a)

Figure 1 (a) – Number of accidents by category

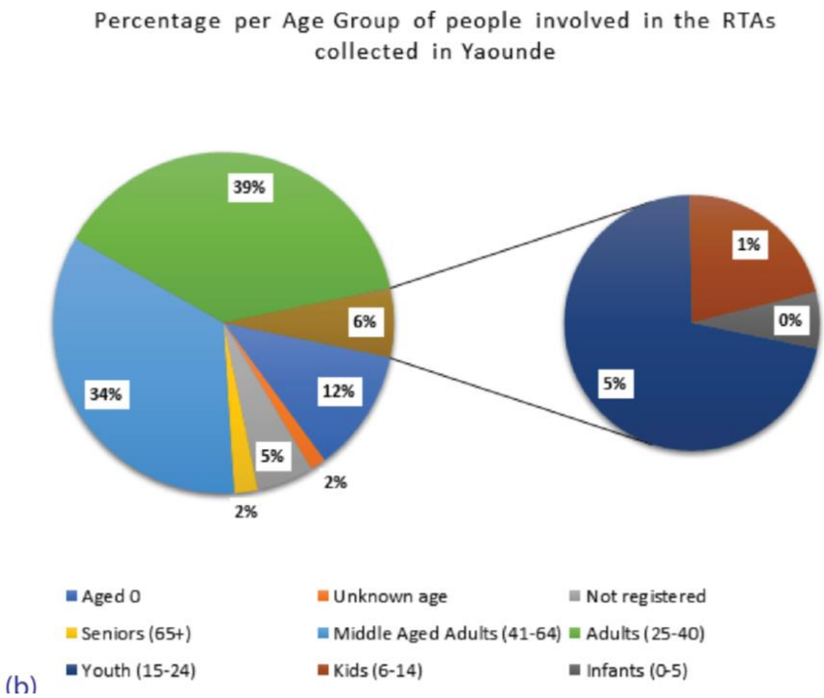


Figure 1 (b) – Percentage of accidents by age group

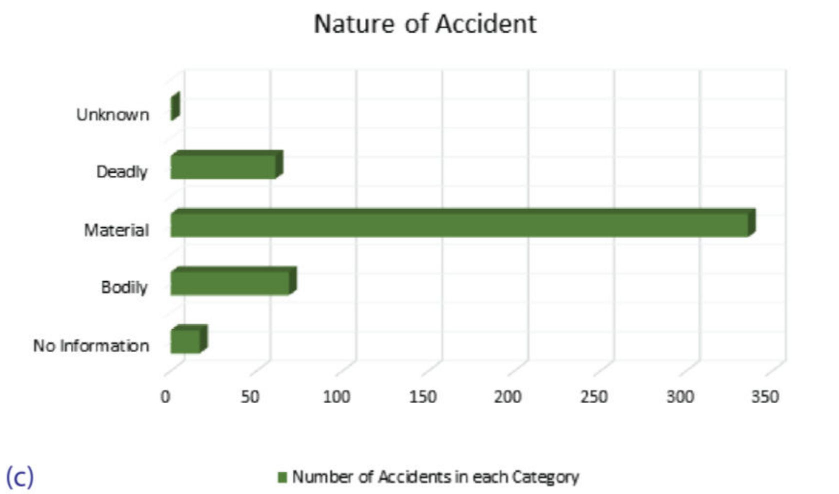


Figure 1 (c) – Number of accidents by nature of accidents

4.2. Star Rating Scores (SRS) for High Risk Road Sections

The road accidents were placed on a digital map using GoogleMaps and then the areas with the highest clusters of accident points generated a risk map. A section of the roads in Yaoundé was selected along the Boulevard de la Reunification. This road section has a length of 1.6 km (from Carrefour EMIA to Monument de la Reunification) with 10 accidents in the duration of October 2018 to September 2019 and two deaths were recorded. This road section has 5 schools.

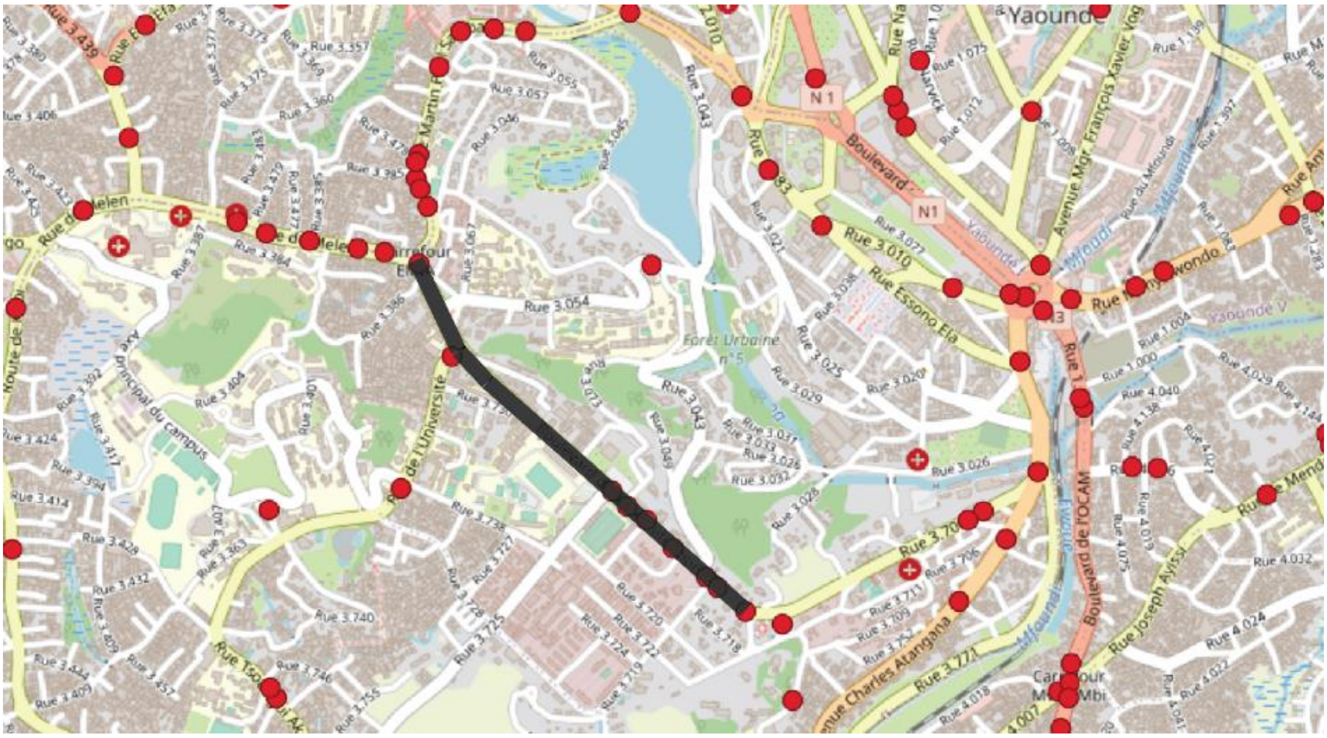


Figure 2 - Selected road section from Carrefour EMIA to Reunification Monument (Boulevard de la Reunification)

The iRAP survey on the existing road network shows that 0.1km out of the 1.6km has no functional footpath, 1.6km have no bicycle and motorcycle facilities and of the 11 intersections present where traffic flows at 60km/h or more, 9 have no roundabout, protected turn lane or interchange. The full set of attributes can be consulted from http://vida.irap.org/ using the results area with the name Tevoh Baseline

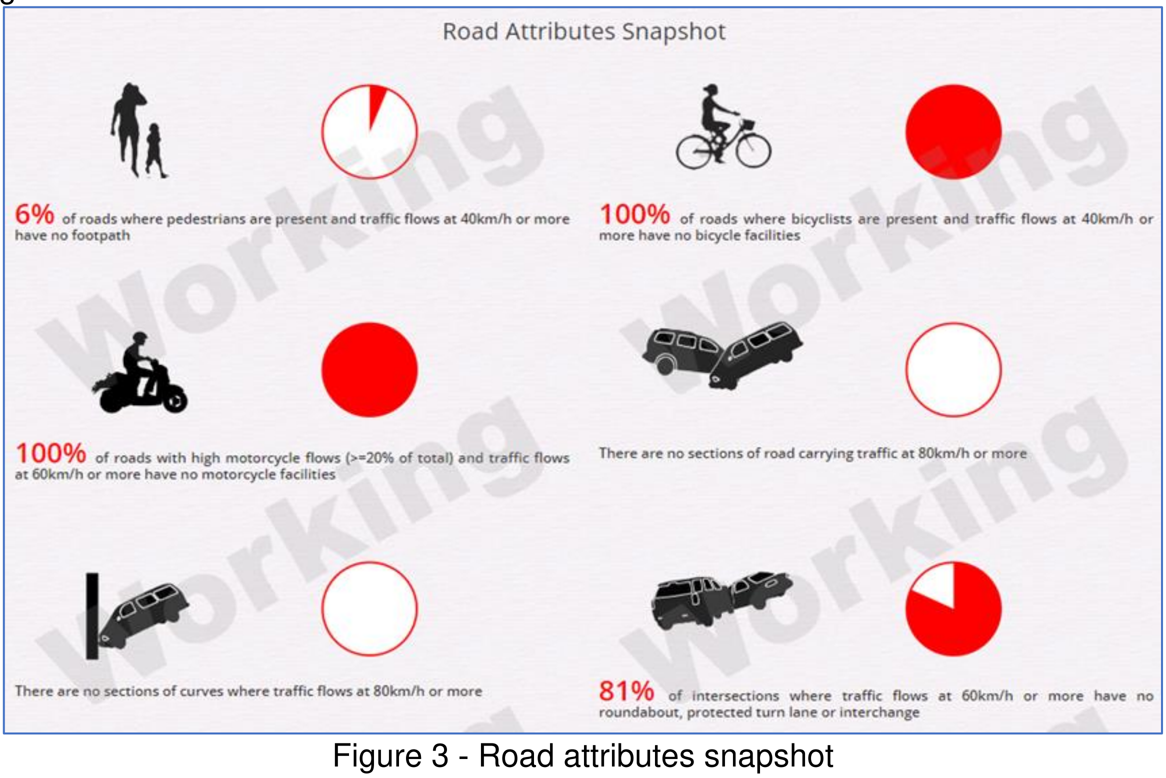


Figure 3 - Road attributes snapshot

The road section analyzed was the road from Carrefour EMIA, passing through CETIC Ngoa Ekele, the National Assembly and ending at The Reunification Monument. A Star Rating Score (SRS) is only produced if a flow of the particular road user is recorded. For example, if no pedestrians are present, then no SRS is produced. SRS is also not produced when major road works are being undertaken. The Star Ratings are based on road inspection data and provide a simple and objective measure of the level of safety which is ‘built-in’ to the road for all road users. The star rating is focused on individual relative risk for four user groups – vehicle occupants, motorcyclists, bicyclists and pedestrians

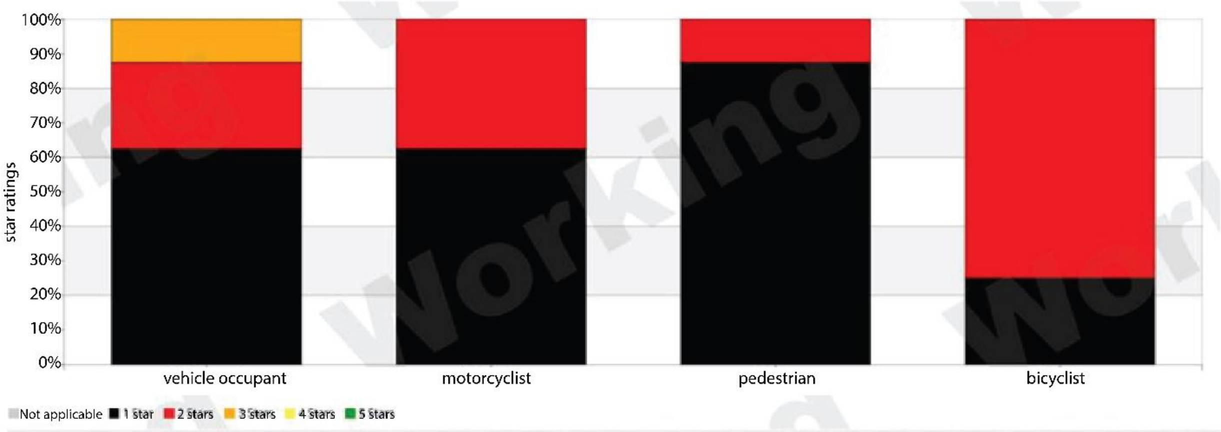


Figure 4 - Star Rating Chart for Baseline

This assessment shows that this road section is 1 star for all users which indicates that the road network gives a higher risk for all road users. Table 1 illustrates the current star ratings for the road section

Table 1- Baseline Star rating table (smoothed)

	Vehicle Occupant		**Motorcyclist**		**Pedestrian**		**Bicyclist**	
Star Ratings	Length (km)	Per cent	Length (km)	Percent	Length (km)	Percent	Length (km)	Percent
5 Stars	0	0.00%	0	0.00%	0	0.00%	0	0.00%
4 Stars	0	0.00%	0	0.00%	0	0.00%	0	0.00%
3 Stars	0.2	12.50%	0	0.00%	0	0.00%	0	0.00%
2 Stars	0.4	25.00%	0.6	37.50%	0.2	12.50%	1.2	75.00%
1 Star	1	62.50%	1	62.50%	1.4	87.50%	0.4	25.00%
Not applicable	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Totals	1.6	100.00%	1.6	100.00%	1.6	100.00%	1.6	100.00%

From the table 1, 100% of roads have 3 stars and less for pedestrians, bicyclists and motorcyclists (vulnerable road users) and only 12.5% of the section have 3-star ratings for vehicle occupants. This, therefore, suggests that vulnerable road users are at a greater risk on the road and hence interventions to elevate star ratings should be targeted to especially vulnerable road users, specifically pedestrians. Given that the study is focused to provide solutions for Safer Routes to school, the pedestrian risks map for the study area was also analysed as shown in figure 5 below. The figure shows the distribution of star ratings along different sections of the road network with a star rating of 1 (black) showing the riskiest road sections and 2 stars red region.

Figure 5 - pedestrian risk map (Baseline)

The estimated distribution of Fatalities and Serious Injuries likely to occur along this Baseline(existing) Road network per year, for different road users, was calculated in the ViDA software. The figure 6 illustrates the FSI (values and percentages) for different road users likely to occur per year on the road segment.

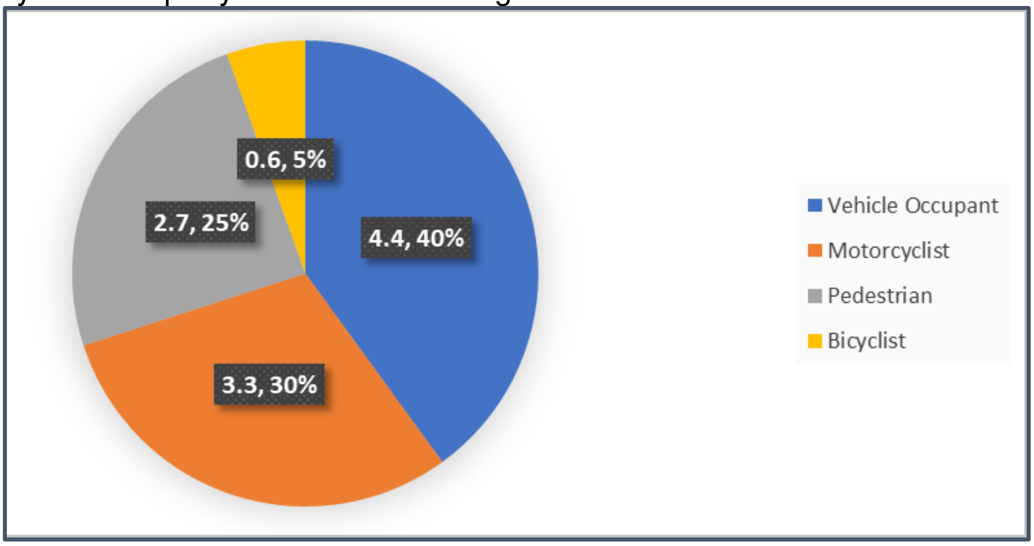


Figure 6 - FSI values and percentages for different road users likely to occur per year on our given road segment

4.3. Star Rating Scores (SRS) Countermeasures Applied on Road Sections

This part of the analysis involved checking the impacts designs and infrastructure improvements will have on the Star Ratings. The design aspects considered include: adding sidewalks (Non-physical separation 0m to <1.0m) on both sides of the road, upgrading pedestrian crossings to marked crossings with refuge, provision of school static signs, school zone supervisor and implementing a 30km/h speed Zone[27][28][29]. Theoretical analysis of the design changes shows that targeted interventions are designed to protect pedestrians (otherwise students on their way to school). It is therefore expected to have changes in star ratings for pedestrians. The results of the star ratings for each road user are presented in figure 7.

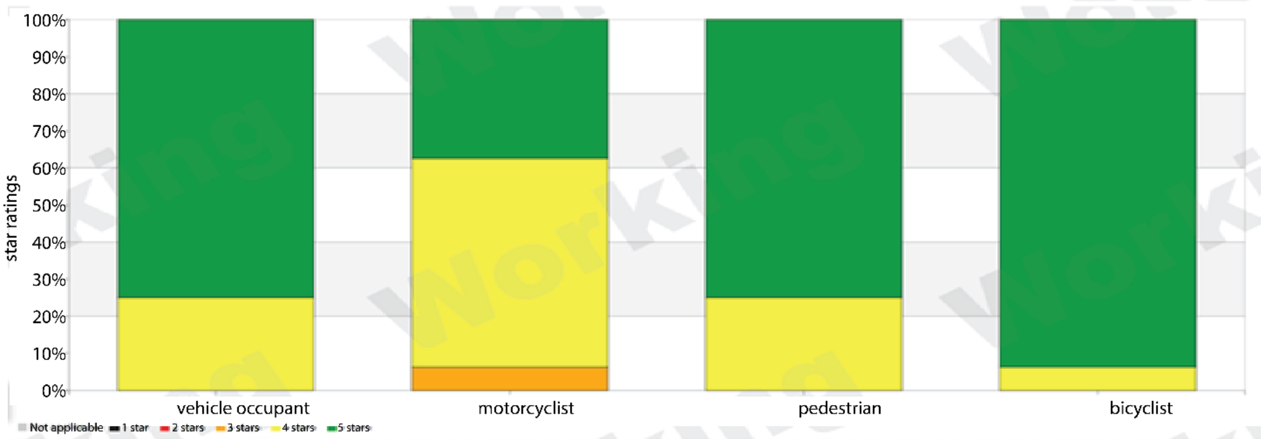


Figure 7 - Star Rating chart after implementation of the designs

If the designs are implemented the star ratings generated show an improvement in pedestrian star ratings, with 100% of roads having 3 stars and above, which is in line with the sustainable development goal target. There are remarkable improvements in star ratings for other road users, with all achieving 3 stars and above. Table 2 summarizes the results of the analysis.

Table 2. Design Star Rating Results table (smoothed)

	Vehicle Occupant		**Motorcyclist**		**Pedestrian**		**Bicyclist**	
Star Ratings	Length (km)	Percent	Length (km)	Percent	Length (km)	Percent	Length (km)	Percent
5 Stars	1.2	75.00%	0.6	37.50%	1.2	75.00%	1.5	93.75%
4 Stars	0.4	25.00%	0.9	56.25%	0.4	25.00%	0.1	6.25%
3 Stars	0	0.00%	0.1	6.25%	0	0.00%	0	0.00%
2 Stars	0	0.00%	0	0.00%	0	0.00%	0	0.00%
1 Star	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Not applicable	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Totals	1.6	100.00%	1.6	100.00%	1.6	100.00%	1.6	100.00%

The figure 9 below shows pedestrian star ratings and a noticeable improvement in safety is noticed as most road sections achieve star rating scores of 3 stars or better. One can therefore conclude that the implementation of the countermeasures is important to reduce the risk of pedestrian crashes

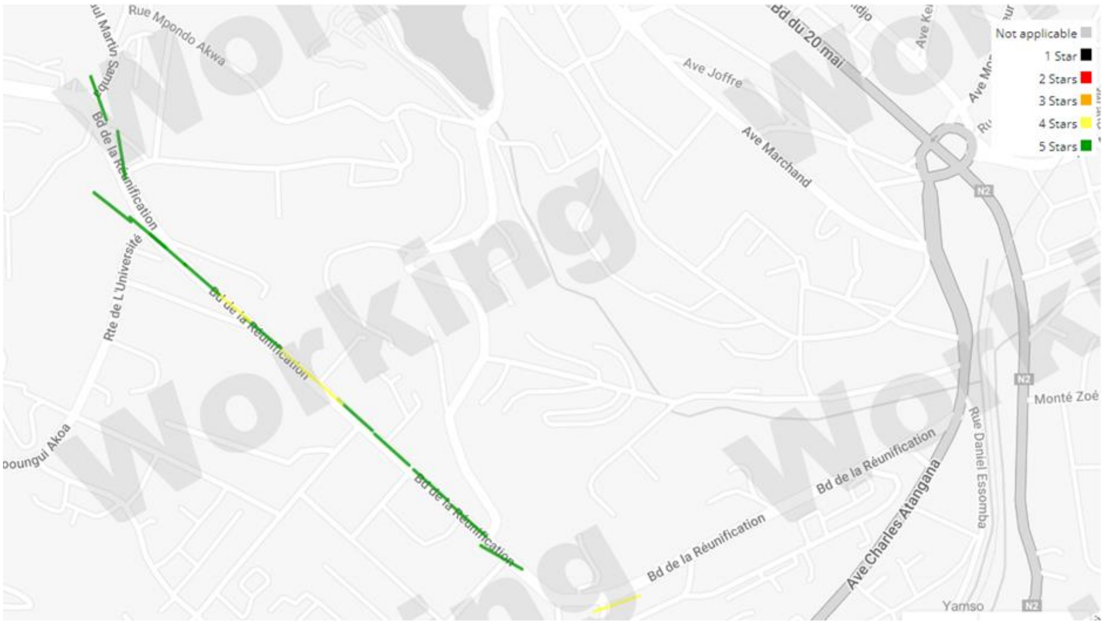


Figure 9 - Pedestrian Risk Map (Design)

The estimated distribution of Fatalities and Serious Injuries likely to occur along the road network per year if the designs are implemented are expected to reduce for each road user (and more significant to the pedestrians). The comparison between the baseline and design scenario is summarized in Table 3.

Table 3 - Accident reduction between baseline and design scenario

	Vehicle Occupant	Motorcyclist	Pedestrian	Bicyclist	Total
Baseline	4.4	3.3	2.7	0.6	11
Design	0.7	0.5	0.1	0	1.3
Difference	**3.7**	**2.8**	**2.6**	**0.6**	**9.7**
% reduction	**84.1**	**84.8**	**96.3**	**100.0**	**88.2**

The results indicate that 88.2% of fatalities and serious injuries for all users will be saved if the implementations are carried out. The percentage reduction in the number of accidents is very significant for pedestrians with a reduction of up to 96%. Hence these implementations will be able to protect students on their way to school. The figure 10 shows the graphical comparison between baseline and design.

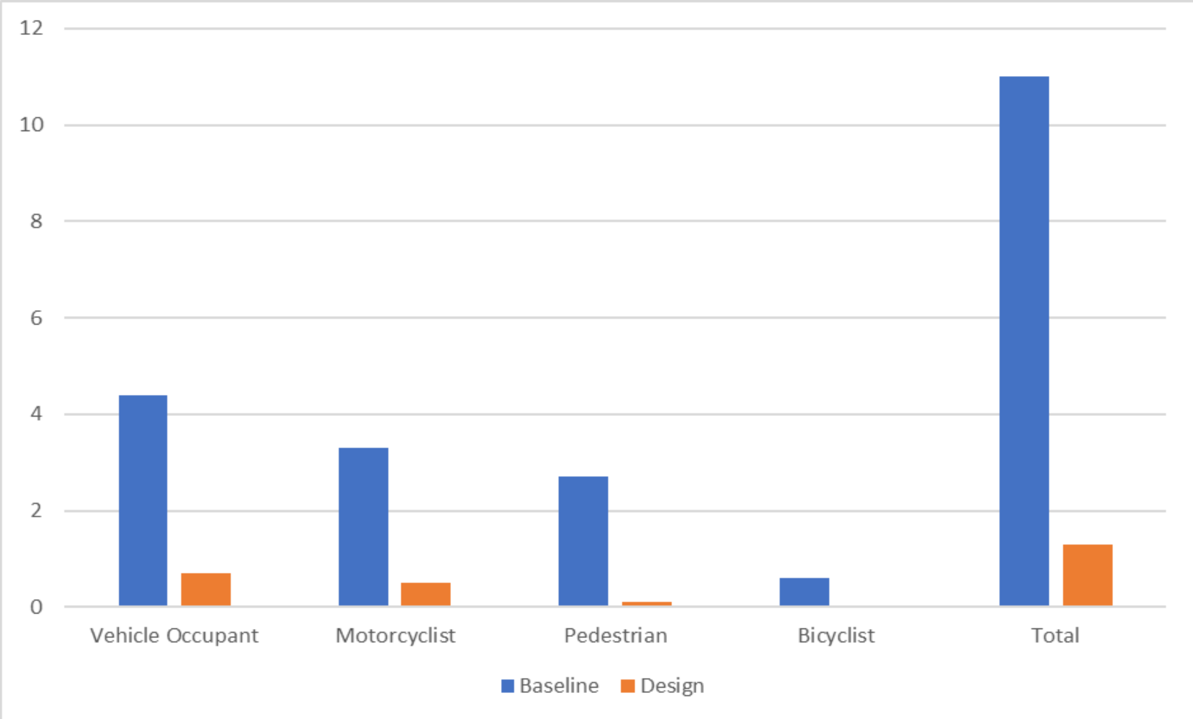


Figure 10 - Differences in fatalities and serious injuries between Design and Baseline

5. CONCLUSION

The number of Fatalities and Serious Injuries (FSI) on Routes to Schools is on the rise and innocent lives of the young are lost while fending for education. This study aimed at analysing the existing situation and proposing countermeasures to reduce the number of children or youths that get killed or seriously injured (KSI) while going to school. Using low-cost methods for data collection and the application of iRAP methodologies and tools (ViDA and SR4D), we have been able to see how the risk of these daily commuters can be reduced. In the general analysis of the accident data, we can conclude that Yaoundé is a very risky town because about 1 in 10 of all accidents in an accident involving a pedestrian and a vehicle and 12.6% of all accidents are deadly where every deadly accident the probability of a pedestrian dying is greater than 60%. The accidents affect mostly the individuals in the age group 25-64 years (73%) and 11.18% percent of all the accidents involve pedestrians. Applying the countermeasure upgrades of the selected road section gives an estimated reduction in risk of 88.2% and particularly for pedestrians, 96.3%.
Efforts that go beyond engineering to ensure that planning and design are integrated with an appreciation of local road user behaviour are necessary. This will require the engagement of the community, enforcement agencies, educators and all other stakeholders of road safety, following a safe system approach. Local knowledge of road users' behaviour particularly for pedestrians' safety is important as some interventions might not work due to user behaviour and their interactions with the built environment. The engineering measures should be complemented with measures that target risks due to human behaviour. Enforcement of laws relating to driving/parking on footpaths; exceeding the posted speed limit; alcohol; seat belt; and failing to yield to pedestrians on pedestrian crossings is especially important. Taking into consideration the problems that contribute to traffic accidents and the results presented, a lot still has to be done in road safety in Cameroon, especially in reducing to speed limit to the recommended 30km/h and future research in domains not limited to the transferability of these countermeasures have to be done.

6. ACKNOWLEDGEMENTS

iRAP for the training courses, the provision of free software and advocacy work inform and unlock important national and/or development financing for road upgrades. These resources have done great work in reducing road casualties and will still go a long way.

REFERENCES

1. WHO, "Road traffic injuries." https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries (accessed May 09, 2022).
2. iRAP, "Vaccines for Roads 3 Summary," Hampshire, 2015.
3. "Global Road Safety Facts for Children | Safe Kids Worldwide." https://www.safekids.org/global-road-safety-facts-children-safe-kids-worldwide (accessed Jul. 19, 2022).
4. D. Bose, P. V Marquez, and S. Job, "The Cost of Inaction: Can We Afford Not to Invest in Road Safety? Estimated long-term GDP per capita increase by halving road crash deaths and injuries in select countries," 2018, Accessed: Jul. 19, 2022. [Online]. Available: http://www.worldbank.org/transport/connections.
5. UNICEF, "Safe to learn; safe journeys to school are child's right," 2015. [Online]. Available: https://www.unicef.org/education/files/Safe_to_Learn_report.pdf
6. "Star Rating For Schools." https://starratingforschools.org/ (accessed Jul. 19, 2022).
7. UNESCWA, "road traffic safety." https://archive.unescwa.org/road-traffic-safety (accessed Jul. 19, 2022).
8. WHO, "Road traffic injuries." https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries (accessed Jul. 19, 2022).
9. WHO, "World report on road traffic injury prevention," Geneva, 2004.
10. "Road Safety | SSATP." https://www.ssatp.org/topics/road-safety (accessed Jul. 19, 2022).
11. NHTSA, "Traffic Safety Facts," 2005.
12. J. Damani and P. Vedagiri, "Safety of motorised two wheelers in mixed traffic conditions: Literature review of risk factors," *J. Traffic Transp. Eng. (English Ed.*, vol. 8, 2021, doi: 10.1016/j.jtte.2020.12.003.
13. "Road Safety in Cameroon | Traffic accidents, crash, fatalities & injury statistics | GRSF." https://www.roadsafetyfacility.org/country/cameroon (accessed Jul. 19, 2022).
14. UNECE, "Road Safety: Cameroon Must Redouble Its Efforts and Strengthen Coordination | UNECE." https://unece.org/road-safety-cameroon-must-redouble-its-efforts-and-strengthen-coordination-0 (accessed Jul. 19, 2022).
15. World Bank, "Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Countries Country Profiles," Washington, DC.,USA, 2019.
16. "Where we work - iRAP." https://irap.org/about-us/where-we-work/ (accessed Jul. 19, 2022).
17. "RAP Tools - iRAP." https://irap.org/rap-tools/ (accessed Jul. 19, 2022).
18. "iRAP Methodology fact sheets - iRAP." https://irap.org/methodology/ (accessed Jul. 19, 2022).
19. "Safe Routes to School Programs | US Department of Transportation." https://www.transportation.gov/mission/health/Safe-Routes-to-School-Programs (accessed Jul. 19, 2022).
20. M. G. Boarnet, C. L. Anderson, K. Day, T. McMillan, and M. Alfonzo, "Evaluation of the California Safe Routes to School Legislation: Urban Form Changes and Children's Active Transportation to School," Sep. 2006. [Online]. Available: https://ideas.repec.org/p/cdl/uctcwp/qt3vd3g3jm.html
21. A. Agrawal *et al.*, "Safer Roads to School.," *J. Emerg. Trauma. Shock*, vol. 13, no. 1, pp. 15–19, 2020, doi: 10.4103/JETS.JETS_71_19.
22. R. Tak and L. Hirandas, "Six ways to design safer school zones - Ideas4Action," Apr. 05, 2022. https://cities4children.org/blog/ideas4action-six-ways-to-design-safer-school-zones/ (accessed Jul. 26, 2022).
23. FiA Foundation, "Annual Review 2021," 2021.
24. WHO and Margie Peden, "World report on road traffic injury prevention: Summary," Geneva, 2004.
25. J. Jin and P. Rafferty, "How the speed limit policy affects travel speed?: Quasi-experimental approach," *Transp. policy*, vol. 103, pp. 2–10, 2021.
26. T. Sayed and E. Sacchi, "Evaluating the safety impact of increased speed limits on rural highways in British Columbia," *Accid. Anal. \& Prev.*, vol. 95, pp. 172–177, 2016.
27. Austroads, "Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings," Sydney, 2019. Accessed: Jul. 26, 2022. [Online]. Available: https://austroads.com.au/publications/traffic-management/agtm20/media/AGTM06-19_Guide-to_Traffic_Management_Part_6_Intersections_Interchanges_and_Crossings.pdf
28. A. P. W. Hoong *et al.*, *Evaluating Road Safety Risks at Schools in Selangor : An iRAP Approach*. 2021.
29. N. Transport Agency, "Pedestrian planning and design guide," 2009.