The importance of road construction engineering in preventing pedestrian fatalities in Limpopo Province

Modipa Mmakwena
Tshwane University of Technology,
2 Aubrey Matlakala St, Soshanguve, Pretoria, South Africa.
Corresponding author: modipamv@tut.ac.za

OIDA International Journal of Sustainable Development, Ontario International Development Agency, Canada.
ISSN 1923-6654 (print) ISSN 1923-6662 (online) www.oidaijsd.com
Also available at https://www.ssrn.com/index.cfm/en/oida-intl-journal-sustainable-dev/

Abstract: The human suffering caused by road traffic accidents is substantial, primarily due to inadequate road infrastructure. Beyond the significant loss of life and injury, road accidents also place a heavy financial strain on the nation, encompassing losses in productivity, healthcare costs, social welfare, and the emotional toll of pain, grief, and suffering. The Department of Transport, its affiliated agencies, and road construction firms have a critical responsibility in ensuring a safer and more secure road network. This study employed a quantitative research approach, involving a sample of 195 respondents, including 15 civil engineering firms, 23 civil society organizations, 52 community members, 51 teachers, and 54 traffic police officers. The findings from the study revealed among many others, most of the study respondents (72%), either strongly agreed or agreed with this hypothesis. However, those who were 36 years and above, as well as the singles strongly agreed or agreed the most. 9.40% indicated a "don't know" response to this hypothesis, while 18.60% disagreed or strongly disagreed that road construction engineering could prevent pedestrian fatalities in Limpopo Province. Therefore, based on the responses, road construction engineering could prevent pedestrian fatalities in Limpopo Province. Based on the findings of the study the author provided possible recommendations such as separating pedestrians from cars, enhancing visibility at night, and reducing motorised speeds as well as meeting the need for road infrastructure improvements.

Keywords: Road safety engineering, pedestrians, fatalities, Limpopo Province and South Africa

Introduction

The World Economic Forum (2015) emphasized that roads are essential to economic growth, serving as lifelines that connect producers to markets, workers to jobs, students to schools, and the sick to hospitals. Roads are, therefore, integral to any development strategy. Since 2002, the World Bank has financed the construction or rehabilitation of more than 260,000 kilometers of roads, allocating more funding to roads than to education, health, and social services combined. Ensuring road safety through effective engineering is critical to maintaining the quality of road infrastructure and catering to all road users. Historically, roads have been designed primarily for vehicles, often neglecting the needs of pedestrians. Research shows that enhancing infrastructure for cyclists can have a positive economic impact, with those walking or cycling to commercial areas spending more money monthly compared to those arriving by car (Flusche, 2012).

In South Africa, non-motorized transportation remains a significant reality. According to the National Household Travel Survey, 2.9 million workers walk to their places of employment, and many learners commute to school on foot. However, pedestrians are among the most vulnerable road users, accounting for nearly half of all road fatalities (1,456 of 3,904) recorded by the Road Traffic Management Corporation between October and December 2016 (Naidoo, 2017). Mutabazi (2008) pointed out that the dominance of motor vehicles in road design has contributed to high pedestrian fatality rates. Road engineers should account for rural communities, schools, and informal trading activities along road reserves, all of which increase pedestrian presence on national roads. Pedestrian safety is also compromised by the inappropriate use of pedestrian amenities. Sidewalks are frequently occupied by commercial businesses, sidewalk vendors, and petty merchants, especially at intersections, forcing pedestrians to walk on the road, increasing the risk of accidents. Creating walkable and bike-friendly communities begins with designing environments where destinations are close to one another, such as schools, parks, and public spaces, while also allowing for mixed-use developments and appropriate density to support public transit. These areas should also feature commercial districts that are accessible by foot, bicycle, or wheelchair (Bushell, Poole, Zegeer & Rodriguez, 2013).

Enhancing pedestrian and cycling infrastructure benefits all road users. New York City's 2011 Sustainable Streets Index revealed that improvements such as pedestrian islands and bicycle paths led to a reduction in motorist and injury crashes, decreased speeding, and increased pedestrian and cycling activity (New York City Department of Transportation, 2011). Moreover, curb ramps are essential for providing access between sidewalks and streets, especially for individuals using wheelchairs, strollers, or bicycles, and should be prioritized in urban areas near transit stops, schools, and medical facilities (Bushell, Poole, Zegeer & Rodriguez, 2013). Designing well-connected and user-friendly pedestrian infrastructure benefits entire communities. Encouraging walking as a mode of transport fosters sustainable, healthy, and safe communities, and facilitates independent travel for the elderly, children, families, and people with disabilities (Department of Transport, Planning & Public Transport Authority, 2016). This article examines the role of road engineering in reducing pedestrian fatalities in Limpopo Province and proposes practical solutions aligned with the United Nations Decade of Action for Road Safety 2016-2030.

Road safety engineering

Effective engineering plans incorporate both infrastructure and technology to ensure road safety. A well-planned infrastructure helps mitigate road hazards and promotes safer conditions for all road users. In addition, technologies related to vehicles and infrastructure enhance road safety, reducing the occurrence of fatal accidents (Price Waterhouse Coopers, 2017). Roadway design and intersection signal controls are key components of a safe system approach for pedestrian protection. When paired with a comprehensive pedestrian safety strategy, numerous measures can be implemented to enhance safety (Canadian Council of Motor Transport Administrators, 2013).

Pedestrian safety countermeasures can be broadly categorized, including separating pedestrians from vehicles through spatial or temporal means, minimizing or eliminating simultaneous movements of vehicles and pedestrians, shortening crossing distances, improving pedestrian visibility through enhanced lighting, alerting drivers to the presence of crosswalks, and reducing vehicle speeds. The Bloomberg Global Road Safety Program (2012) reported that road safety infrastructure improvements can lower the risk of fatalities and injuries by 25–40% for all road users, including drivers, motorcyclists, cyclists, and pedestrians. Examples of such improvements include widening shoulder lanes, enhancing intersections, and installing medians, side barriers, crosswalks, and lane markings. Pedestrians are legitimate users of road networks and should be able to walk and cross streets safely and without unreasonable delays. Except on expressways and high-speed freeways, pedestrians have the right to use roads, and planners and engineers have a duty to design and implement safe walking and crossing facilities (Maryland Department of Transportation, 2005). In Florida, USA, engineering countermeasures targeted at high-crash zones significantly reduced pedestrian accidents. The NHTSA pedestrian safety project achieved a 13.3% reduction in crash rates along identified corridors, while the FHWA engineering safety project reduced pedestrian crashes by 49.5% from baseline levels. This equates to 50 fewer pedestrian crashes annually along treated corridors (Ellis & Van Houten, 2015).

Sidewalks and walkways play a critical role in enhancing pedestrian safety and mobility, particularly in urban and suburban areas. On rural roads, shoulders should be provided to accommodate pedestrian travel. Permits for new road construction and reconstruction should require that safe pedestrian access be integrated into planning as a condition for approval (Maryland Department of Transportation, 2005). Reducing the frequency and severity of road accidents can be achieved by adopting and enforcing effective safety measures. For example, innovative technologies in vehicle manufacturing can help South African motorists consider pedestrian safety when purchasing new vehicles. Many newer cars are equipped with crumple zones designed to minimize damage during pedestrian collisions and warning systems (such as park assist) that alert drivers to obstacles in their path. These technologies aim to reduce the harm caused to pedestrians, and greater collaboration is needed to further prevent pedestrian fatalities in the region.

Road safety is a significant public health concern, and the health of the nation takes precedence over its wealth. Strict enforcement of road safety measures can significantly reduce injuries and fatalities resulting from traffic accidents (Desai and Patel, 2011). Attention to these measures is crucial to improving road safety in South Africa. It is important to prioritise the safety of road users, by implementing safety measures at high accident zones in Limpopo Province. This could be achieved through road construction engineering designing roads which will accommodate all road users, because in the past the designers did not consider the safety of pedestrians when designing the roads. The results of poor road design had a severe damage to roads, road users and financial budgets.

Lack of road signs, traffic lights, pedestrian bridges, streetlights, road marking, drainage systems and other basic road safety measures, contribute negatively on the safety of pedestrians. In the past years in Limpopo Province, some of the major roads did not have roundabouts, traffic lights and other basic road safety measures. There were a lot of accidents, for example at the GaMothapo and Mothiba intersection, there were headlines about the Polokwane City players and other pedestrians, being killed at that intersection in 2012.

It is important to build roads which will contribute to traffic calming and prevent road traffic accidents. Road construction engineering should accommodate all the aspects of road users, especially the pedestrians, to ensure that the roads are in good condition. A feature of traffic characteristics in developing countries like South Africa, is the large numbers of pedestrians and cyclists. It is common for road design and traffic control measures to be geared to meeting the demand of motorized traffic in interaction with a limited number of pedestrians and cyclists (Falck-Jansen, Kildebogaard & Robinson, 2013). Furthermore, problems can also arise within intersections, because of the conflicts between different categories of traffic. Often, large proportions of pedestrians and cyclists obstruct the intended flow of motorised traffic. High numbers of pedestrians and cyclists may change the nature of the traffic flow, because in the past most of the roads were designed in such a manner that pedestrians and cyclists were excluded. Even in South Africa, some of the roads in rural areas like in Limpopo Province, the design does not accommodate the pedestrians. It is important for road designers to ensure that, during the planning and implementation phase, they accommodate the safety of pedestrians. According to the European Transport Safety Council (2018), the road sector is currently facing significant challenges, including the need to meet demanding expectations such as faster, higher-quality, and more cost-effective production, construction, and maintenance processes. To reduce the amount of time roads are closed for maintenance, the overall quality of road construction must be improved. Additionally, the time allocated for repair and rehabilitation work is becoming increasingly limited, requiring maintenance techniques to become more efficient. Moreover, stricter environmental regulations are being imposed concerning air pollution, noise emissions from traffic, and the consumption of natural raw materials, making compliance more challenging.

These situations are also leading to a new series of questions and problems. For example, most of the roads in rural areas are not getting maintenance in relation to potholes, clear road signs, gravel roads, pedestrian bridges, signs for reflective clothing, etc. It is important for municipalities, as well as the provincial government, to work together in ensuring that roads, which have high traffic accidents involving pedestrians, should have street lights, speed cameras, signs for reflective clothing so that road users could be reminded to adhere to those rules and avoid being involved in road traffic accidents. Most of the roads in Limpopo Province are not properly marked and have two lanes with no yellow line for pedestrians to use. In these areas the road dividing the community into two, does not have street lights and as a result it puts pedestrians at risk of being hit by motorists. Therefore, it is of paramount importance for the agency under the Department of Transport, which is South African National Roads Agency Limited (SANRAL), to identify hotspots and improve the conditions of the roads to be safer for all road users, especially pedestrians.

Limpopo Province needs to extend some of the roads to three lanes, as the traffic volume has increased over the years, and so many vehicles and pedestrians use those roads that some of them get involved in road traffic accidents as result of just two lanes. For example, the road to Dendron R521 and Mokgopong has a lot of trucks and vehicles travelling on these roads and much should be done to ensure that road users are safe whenever they use the road, especially pedestrians. Road construction engineering needs a collective responsibility in building roads that are up to standard in Limpopo Province. Construction companies who are awarded tenders to build the roads, must have experience in road construction, because in the past some of the tenders were awarded companies who are connected to politicians and not delivering to the safety of road users as was reported all over the media. Things need to change to ensure that everything that pertains to road safety is given priority, because human life matters most. As one of the traffic calming measures, much will be outlined as to how other components of engineering could be used for the safety of road users. The Department of Transport, South African National Roads Agency, road construction companies, municipalities and other stakeholders, should join hands and work together to ensure that standards are up to date, as it accommodates all road users, especially vulnerable road users, such as pedestrians.

Methodology

Study population

McBurney (2001) described the study population as the sampling frame, referring to the total group of persons, events, organizations, case records, or other sampling units that are relevant to the research problem. Similarly, Wegman, Aarts, and Bax (2007) emphasized that a population comprises individuals, groups, organizations, products, or events subject to study, while Bless, Higson-Smith, and Sithole (2013) defined a study population as the set of elements that the research focuses on. In quantitative research, the findings from the sample should ideally be generalizable to the broader population. Statistics South Africa (2016) reported that Limpopo Province's population grew from 5.4 million in 2011 to 5.8 million in 2016, making it the fifth-largest province by population. The number of households also increased from 1.4 million in 2011 to 1.6 million in 2016. This study was conducted in the Capricorn district, focusing on respondents over the age of 18, as they were more likely to comprehend the issue of pedestrian fatalities. The research sample included community members, municipal and traffic police officials, members of civil society organizations, road construction companies, and teachers, as these groups are directly impacted by road safety issues, particularly regarding pedestrians. Their inclusion was essential to achieve the study's objectives. All respondents from the province participated to provide insights into the problem of pedestrian fatalities, helping to enrich the study with knowledge, attitudes, and strategies for preventing such incidents

Sample size

According to Bless et al. (2013), a sample is a portion of the overall population, and for it to be effective in research, it should possess all the characteristics of the population to accurately reflect the entire group. In this study, the research sample included 54 Municipal/Traffic police officers, 51 Teachers, 23 representatives from Civil Society Organisations, 15 individuals from Road construction companies, and 52 members of the community, making the total sample size 195

Sample procedure

The following sampling procedures were used in this study:

Probability sampling

According to Bless *et al.,* (2013), probability sampling is when the probability of including each element of the population can be determined. It is thus possible to estimate the extent to which the findings based on the sample are likely to differ from what would have been found by studying the whole population. Simple random sampling was used in this study. Bless *et al.,* (2013), stated that, as a sampling procedure, simple random sampling provides equal opportunity of selection for each element in a population. Therefore, every member of the population has a chance to participate in the study irrespective of sex, race, age, and so on. Members of the population will have an equal chance to be included, which will make a difference in their approach in terms of conducting themselves on the road. It will also add value in terms of knowledge, skills and attitude gained through participating in this study and as a result it will significantly contribute to road safety.

Stratified random sampling

Stratified random sampling is suitable for a heterogeneous population because the inclusion of small groups, percentage wise can be ensured (De Vos, Strydom, Fouché, & Delport, 2011). This kind of sample is mainly used to ensure that the different segments or groups of the population have enough representation in the sample (Creswell, 2003). Fifty-two (52) members of the community provided data through the completion of questionnaires, which included factory workers, bus drivers, cleaners, extended public works program workers, street vendors, etc. Fifty-four (54) municipal/Traffic police officials provided data through the completion of questionnaires. This increased the availability of adequate lists and facilitated the selection of a simple random sample without decreasing the quality of the sample.

Purposive sampling

This technique is also called judgmental sampling. According to Rubin & Babbie (2005), the sample is based entirely on the judgement of the researcher, in that a sample is composed of elements that contain the most representative characteristics or typical attributes of the population that serve the purpose of the study best. Twenty-three (23) Civil society organisations took part in the study, as the researcher wanted to determine their role in preventing road traffic accidents, especially the pedestrians, because some of these victims are their members It is important for them to be part of the study and also take important aspects of road safety to their members and ensure that they adhere to the rules of the road. Fifty-one (51) Teachers were also given questionnaires to complete as these accidents affect their schools and the researcher wanted to know what they were doing to curb the problem of pedestrian fatalities, as it has an impact on their schools. Lastly, fifteen (15) Road Construction companies were given questionnaires to complete with a view to determine their role(s) in dealing with pedestrian fatalities. Civil Society Organisations were included in the study because the researcher wanted to determine whether they were contributing to the prevention of road traffic fatalities, such as promoting road safety during their Lekgotla or conferences because they also lose members through road traffic fatalities and on strengthening their relationship with law enforcement agencies in terms of how to curb this problem.

Method of data collection

De Vos et al. (2011) highlighted that quantitative data collection frequently utilizes measurement instruments, such as questionnaires, particularly in the social and human sciences. Quantitative research seeks to explain phenomena by collecting numerical data that are then analysed using statistical methods. As the primary focus of quantitative research is the gathering of numerical data to explain a phenomenon, questions naturally lend themselves to this approach. Data can be collected on various phenomena and transformed into quantitative information through instruments such as questionnaires. The researcher, therefore, designed a questionnaire and distributed it to all participants. Babbie (2007) defined a questionnaire as a tool comprising questions or items meant to gather information for analysis. While the term "questionnaire" typically implies a set of questions, it may also include statements to gauge respondents' perspectives. According to Babbie and Mouton (2001), the main goal of a questionnaire is to obtain factual information and opinions on a phenomenon from knowledgeable individuals.

Once data were collected, Bless et al. (2013) emphasized the importance of organizing and checking the accuracy and completeness of the data. After completing this step, the researcher applied various mathematical and statistical tests to describe the sample data and generalize the findings to the larger population. Data were gathered from community members, civil society organizations, teachers, municipal and traffic police officers, and road construction companies. The researcher reviewed and analysed the data to draw conclusions using STATA version 12 statistical software. Both preliminary analysis and inferential statistics were employed. A database was developed based on the questionnaire's rules, which defined boundaries for different variables, and the Likert scale was used to measure responses.

Preliminary analysis

A univariate descriptive analysis was conducted on all the original variables, displaying frequencies and percentages. These descriptive statistics are presented in Table 1. The reliability of the questionnaire items was assessed using Cronbach's Alpha test.

Inferential statistics

The following inferential statistics were used:

- **Cronbach's Alpha test**: Cronbach's Alpha is a reliability index that reflects the variation accounted for by the true score of the underlying construct being measured (Schindler & Cooper, 2001). In other words, it measures how well a set of items or variables assesses a single unidimensional latent construct. Low Cronbach's Alpha indicates a multidimensional structure in the data.
- **Fisher's Exact Test for ordinal data**: This test was employed to examine significant differences between groups. The Chi-square test was not used because some cells contained fewer than five responses. A significance level of $p < 0.05$ was applied.
- **Factor analysis**: Factor analysis is a method used to reduce observable variables to a smaller set of latent variables that share common variance, which is known as dimensionality reduction (Bartholomew, Knott, & Moustaki, 2011). In this study, factor analysis was conducted to generate latent variables from the main variables, and factor loading represented the relationship between each variable and the underlying factor.
- **Kruskal-Wallis and Wilcoxon Rank-Sum tests**: These are non-parametric tests used to compare independent samples. The Kruskal-Wallis test is used for more than two independent samples, while the Wilcoxon Rank-Sum (Mann-Whitney U) test is used for two independent samples. These tests were applied in this study to compare groups (e.g., age groups, gender, marital status, and membership in traffic police or education departments). Hypotheses were tested with a significance level set at $p < 0.05$.

Descriptive statistics

Table 1: Descriptive statistics for all the variables

Variables	Categories	Frequency	Percentage out of total (%)
Section A: Biographic variables			
Categories of the study participants	Civil Engineering companies	15	7.69
	Civil Society Organization	23	11.79
	Community Member	52	26.67
	Teachers	51	26.15
	Traffic Police	54	27.69
1. Age group	18–24 Years	33	16.92
	25–30 Years	45	23.08
	31–35 Years	33	16.92
	36 Years and above	81	41.54
	Missing	3	1.54
2. Gender	Male	90	46.15
	Female	101	51.79
	Missing	4	2.05
3. Marital status	Married	78	40.00
	Single	103	52.82
	Divorced	3	1.54
	Missing	11	5.64
4. Member of the Traffic Police/Education Department	Yes	100	51.28
	No	90	46.15
	Missing	5	2.56
5. Years of service	Less than 5	31	29.25
	6–10	27	25.47
	11–15	12	11.32
	16–20	15	14.15
	More than 20	21	19.81
Section B: Road construction Engineering Factors			
6. Safety and well-being of road workers	Strongly Agree	74	37.95
	Agree	56	28.72
	Don't know	26	13.33
	Disagree	18	9.23
	Strongly Disagree	14	7.18
	Missing	7	3.59
7. No pedestrian bridges at hot spot areas	Strongly Agree	70	35.90
	Agree	52	26.67
	Don't know	28	14.36
	Disagree	24	12.31
	Strongly Disagree	16	8.21
	Missing	5	2.56
8. Lack of street lights	Strongly Agree	97	49.74
	Agree	66	33.85
	Don't know	6	3.08
	Disagree	9	4.62
	Strongly Disagree	9	4.62
	Missing		

Variables	Categories	Frequency	Percentage out of total (%)
9. Road maintenance	Strongly Agree	97	49.74
	Agree	62	31.79
	Don't know	13	6.67
	Disagree	7	3.59
	Strongly Disagree	11	5.64
	Missing	5	2.56

Reliability Test

Cronbach's alpha is a commonly used metric to assess the reliability or internal consistency of a set of scale or test items. It evaluates the extent to which a measurement consistently captures a concept. A score lower than 0.70 suggests that the items may not be measuring the same underlying construct. In this study, Cronbach's alpha scores exceeded 0.90 for all items, indicating strong internal consistency and reliability. This suggests that the items consistently measured the factors associated with preventing pedestrian fatalities in Limpopo Province (refer to Table 1). The items, which were designed to assess aspects of road construction engineering, also demonstrated reliability, as none of the Cronbach's alpha values were below 0.70.

Hypothesis Testing

To test the null hypothesis, latent variables were generated through factor analysis. Comparisons were then made to determine if different groups responded differently to the latent variables, which were created by aggregating the variables that loaded onto the road construction engineering factor. These comparisons were performed using non-parametric tests, such as the Kruskal-Wallis test for more than two independent samples, and the Wilcoxon Rank-Sum (Mann-Whitney U) test for two independent samples. These tests were applied to compare responses across groups based on factors such as age, gender, marital status, and whether the participants were members of the traffic police or education departments.

Road construction engineering were tested as follows:

Hypothesis: Road construction engineering could prevent pedestrian fatalities in Limpopo Province.

A study was conducted to test the hypothesis that road construction engineering could help reduce pedestrian fatalities in Limpopo Province. Various demographic groups were analysed to understand how they perceived the effectiveness of road construction engineering.

Impact of Age on Road Construction Engineering Perceptions

There was a statistically significant difference among age groups in their views on *" road construction engineering"*. Participants aged 36 and above had a notably higher average score compared to other age groups, indicating stronger agreement with the effectiveness of road construction engineering in preventing pedestrian fatalities. This finding was supported by a Kruskal-Wallis test (chi-square = 7.834, degrees of freedom = 3, P-value = 0.050), highlighting that older respondents were more likely to believe in the positive impact of road construction efforts.

Gender compared with respect to Road construction engineering factor

No significant differences were observed between male and female respondents regarding their opinions on road construction engineering. Both genders responded similarly to the questions about this factor, as reflected by the Wilcoxon Rank-Sum (Mann-Whitney U) test, which produced a P-value of 0.058. This suggests that both men and women equally agree that road construction engineering could prevent pedestrian fatalities in Limpopo Province.

Marital Status and Agreement with Road Construction Engineering

However, marital status played a significant role in shaping participants' views. Those who were single had a significantly higher average score than those who were married or divorced, indicating stronger agreement with the role of road construction engineering in reducing pedestrian fatalities. The Kruskal-Wallis test yielded a chi-square value of 7.712 with 2 degrees of freedom, and a p-value of 0.0211. This suggests that single respondents were more likely to support the hypothesis compared to married and divorced participants.

Membership in Traffic Police or Education Departments

The study also examined whether being part of traffic police or education departments influenced participants' opinions on road construction engineering. Results showed no statistically significant difference between the two groups (p-value = 0.211), meaning that whether respondents were members of these sectors or not, their views on the effectiveness of road construction engineering were the same. Both groups agreed at similar levels that such engineering could prevent pedestrian fatalities in the province.

While factors such as age and marital status influenced perceptions of road construction engineering, gender and membership in traffic-related or educational roles did not. These findings provide insights into how different demographic groups view road safety interventions in Limpopo Province.

Based on the hypothesis of the study, the following results came out of the analysis and possible recommendations were made:

Worker Safety and Well-Being

The survey results revealed that 66.7% of respondents either agreed or strongly agreed that the safety and well-being of road construction workers are not prioritized, while 13.3% were uncertain, and 16.4% disagreed or strongly disagreed with this statement. Based on these responses, it is clear that construction companies should place greater emphasis on worker safety to prevent pedestrian fatalities at construction sites. Motorists often view road construction workers as an inconvenience, yet they should be regarded as providing a valuable service. Despite perceptions, these workers strive to enhance road safety, and it is the responsibility of drivers to remain vigilant and cooperative. Effective collaboration between road workers and users, especially during construction phases, could significantly reduce accidents, as both parties prioritize each other's safety.

Pedestrian Bridges

A significant proportion of respondents (62.6%) indicated that the absence of pedestrian bridges at high-risk locations contributes to the high incidence of pedestrian fatalities in Limpopo Province. Meanwhile, 14.4% were unsure, and 20.5% disagreed or strongly disagreed with this view. These findings suggest that the Department of Transport, alongside road construction companies, should consider constructing pedestrian bridges at accident hotspots. Research by Grobler (2018) emphasizes that pedestrian fatalities account for approximately 40% of road deaths, exacerbated by poor infrastructure, insufficient law enforcement, and reckless driving behaviors. Erecting pedestrian bridges in high-risk zones, coupled with public awareness campaigns, could help mitigate pedestrian fatalities by physically separating pedestrians from vehicular traffic, thereby improving safety.

Street Lighting

A considerable majority (83.6%) of respondents agreed or strongly agreed that inadequate street lighting contributes to the high rate of pedestrian fatalities in Limpopo Province. Only 3.1% were unsure, and 9.3% disagreed. Improved lighting is crucial for enhancing road safety, as it helps drivers better detect pedestrians, thereby reducing the risk of accidents. According to Patterson and Gillespie (2011), installing streetlights in high-risk areas not only increases community safety but also encourages more evening use of pedestrian pathways. In areas like Mentz and Makanye village near Polokwane, where road accidents frequently occur due to the combination of poor lighting and impaired road users, installing street lights could reduce fatalities. Street lighting has been recognized as an effective and low-cost intervention that can enhance both driver and pedestrian visibility, thus preventing accidents (Beyer & Ker, 2009). It also promotes a safer urban environment, extending the hours of activity and improving the overall quality of life.

Road Maintenance

The survey revealed that 81.5% of respondents agreed or strongly agreed that road maintenance could enhance pedestrian safety in Limpopo Province, with 6.7% unsure and 9.2% disagreeing. Based on these findings, road maintenance is identified as a key factor in reducing pedestrian fatalities. Despite the development of guidelines for traffic control devices and pedestrian safety, there are still many situations where pedestrians, especially those with disabilities, require additional support. Accessible pedestrian signals should be incorporated into street designs to cater to the diverse needs of pedestrians. Improving road conditions, combined with better signage and signals, can significantly enhance safety for both pedestrians and motorists.

One of the major obstacles for road construction companies when it comes to the implementation phase, is that they use materials which are not of good quality to build roads. One of these examples is the pedestrian bridge which collapsed in the City of Johannesburg, where workers and pedestrians were killed and injured and the incidence was reported all over the media outlets in South Africa. Another example, in 2011 in Limpopo Province, in the village called Kgapane, an engineering company was appointed to build roads and bridges in the area. After completion of the project, roads and bridges were washed away, because one of the bridges was built at the townships' Meloding Section, was effectively a hill of soil covered with pavement and it had no concrete layers. It is important for Limpopo Provincial government to identify high accident zones and do road safety audits and where there is a need to implement road markings, they should do so to ensure road safety for all road users. For example, travelling at night on a two-lane road, which does not have markings, causes a high risk of accidents (e.g. head on collisions), as result of the absence of markings. It is important for the Department of Transport to ensure that they prioritise road safety by means of improving the road conditions, by ensuring that all the roads in the province meet the road network standard and also that maintenance to all the roads in the province is maintained by working together with local municipalities, because some of the road traffic accidents are caused by the road environment. In South Africa attention is on human behaviour, which is important, but while they are working on changing the behaviour of road users, all the roads should meet sufficient road safety standards to ensure that road users are safe whenever they are on the road.

Conclusion

This article is focused on the importance of road construction engineering in preventing pedestrian fatalities in Limpopo Province and to get a better understanding on how to counteract pedestrian fatalities. Most of the respondents agreed to strongly agree that road construction engineering contribute to the prevention of pedestrian fatalities in Limpopo Province. It is important to prioritise the safety of road users, by implementing safety measures at high accident zones in Limpopo Province. This could be achieved through road construction engineering, designing roads which will accommodate all road users, because in the past the designers did not consider the safety of pedestrians when designing the roads. The results of poor road design had a severe damage to roads, road users and financial budgets. Lack of road signs, traffic lights, pedestrian bridges, streetlights, road marking, drainage systems and other basic road safety measures, contribute negatively on the safety of pedestrians. At municipal level, a municipal roads infrastructure grant, public private partnerships and own municipality revenue streams should be allocated towards road infrastructure as it is a comprehensible fiscal strategy for the long-term sustainability for providing road infrastructure services in Limpopo Province and to be successful in this strategy more effort should be done in appointing credible and experienced companies to build quality roads.

Acknowledgement

Author contributions: Conceptualization, M.M.; Methodology, M.M.; Data Collection, M.M.; Formal Analysis, M.M.; Writing—Original Draft Preparation, M.M.; Writing—Review and Editing, M.M.; Author has read and agreed to the published the final version of the manuscript.

Institutional Review Board Statement: Ethical review and approval were waived for this study, due to that the research does not deal with vulnerable groups or sensitive issues.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The author declare no conflict of interest

References

1. Arrive Alive. 2010. Decade of Action and Arrive Alive, National road safety strategy 2011–2020. Available online: https://www.arrivealive.co.za/documents/Road%20Safety%20Strategy%20for%20South%20Africa%202011.pdf.

2. Babbie, E. & Mouton, J. 2001.The practice of social research. 8th ed. USA: Oxford University Press.

3. Babbie, E. 2007. The practice of social research. 11th ed. Belmont: Thomson Wadsworth.

4. Bless, C., Higson-Smith, C. & Sithole, S.L. 2013. Fundamentals of social research methods: An African perspective. 5th ed. Cape Town: Juta.

5. Bloomberg Global Road Safety Program. 2012. Leading the worldwide movement to improve road safety. Available online: https://www.bbhub.io/dotorg/sites/2/2014/04/Bloomberg_Road_Safety_Midway_Report_Final.pdf.
6. Bushell, M.A, Poole, B.W, Zegeer, CV & Rodriguez, D, A. 2013. Costs for Pedestrian and Bicyclist Infrastructure Improvements: A Resource for Researchers, Engineers, Planners, and the General Public. Federal Highway Administration and supported by the Robert Wood Johnson Foundation through its Active Living Research program.
7. Canadian Council of Motor Transport Administrators. 2013. Countermeasures to improve pedestrian safety in Canada. Available online: http://ccmta.ca/images/publications/pdf/CCMTA_Pedestrian_Report_Eng_FINAL.pdf
8. Creswell, J.W. 2003. Research Design: Qualitative, Quantitative and Mixed methods approaches. Second Edition, Sage Publications. University of Nebraska, Lincoln.
9. De Vos, A.S., Strydom, H., Fouché, C.B. & Delport, C.S.L. 2011. Research at grassroots for the social sciences and human service professions. 4th ed. Pretoria: Van Schaik Publishers.
10. Department of Transport, Planning & Public Transport Authority. 2016. Planning and designing for pedestrians: guidelines. Available online:http://www.transport.wa.gov.au/mediaFiles/active-transport/AT_WALK_P_ plan_design_pedestrians_guidelines.pdf.
11. Desai, M.M. & Patel, A.K. 2011. Safety measures for Controlling Road Accident Injuries and Fatality. B.V.M. Engineering College, V.V. Nagar, Gujarat, India.
12. Ellis, R & Van Houten, R. 2015. Reduction of Pedestrian Fatalities, Injuries, Conflicts, and Other Surrogate Measures in Miami-Dade, Florida. Available online: https://trrjournalonline.trb.org/doi/abs/10.3141/2140-06.
13. European Transport Safety Council. 2018. Position paper: The revision of the road infrastructure Management Directive. Available Online: https://etsc.eu/position-paper-the-revision-of-the-road-infrastructure-safety-management-directive-2008-96-and-tunnel-safety-directive-2004-54/.
14. Falck-Jansen, K., Kildebogaard, J. & Robinson, R. 2013. Road engineering for development. Available online: http://roadsforwater.org/wp-content/uploads/2013/10/Richard-Robinson-Bent-Thagesen-Road-Engineering-for-Development-2004.pdf.
15. Flusche, D. 2012. Bicycling Means Business: The Economic Benefits of Bicycle Infrastructure. League of American Bicyclists; Alliance for Biking & Walking. Available online: http://bikeleague.org/sites/default/files/Bicycling_and_the_ Economy-Econ_Impact_Studies_web.pdf.
16. International Federation Global Agenda. 2006. Practical guide on road safety: A toolkit for national Red Cross and Red Crescent Societies. Available online: http://www.ifrc.org/Global/Publications/road-safety/road-safety-en.pdf.
17. Kapila, K.K., Prabhakar, A. & Bhattacharjee, S. 2013. Safe road infrastructure design for highways. Available online: http://www.unescap.org/sites/default/files/bulletin83_Article-2.pdf
18. Maryland Department of Transportation. 2005. Recommendations for Transportation Planners and Engineers. Available online: http://www.marylandroads.com/oots/mdbpacengineeringrecommendations.pdf.
19. Mutubazi, M. 2008. Research project on evaluation of the new pedestrian crossing in Trinidad. Department of Civil and Environmental Engineering, University of West Indies, ST. Augustine Campus, Trinidad, West Indies.
20. Naidoo, R. 2017. Prioritising pedestrians and cyclists when building roads. Available online: http://www.infrastructurene.ws/2017/07/07/prioritising-pedestrians-and-cyclists-when-building-roads/.
21. New York City Department of Transportation. 2011. Sustainable Streets Index. Available online: http://www.nyc.gov/html/dot/html/about/ssi.shtml.

22. Price Waterhouse Coopers (PWC). 2017. A guide for policy makers: On reducing road fatalities. Available online: https://www.pwc.com/m1/en/publications/ road-safety/pwc-guide-on-reducing-road-fatalities.pdf.

23. Republic of South Africa (RSA). 1996a.Constitution of South Africa, No. 108 of 1996. Pretoria: Government Printers.

24. Republic of South Africa (RSA). 1996b. National Road Traffic Act, No. 93 of 1996. Pretoria: Government Printers.

25. Republic of South Africa (RSA). 1998b. South African National Roads Agency Limited Act, No. 7 of 1998. Pretoria: Government Printers.

26. Rubin, A. & Babbie, E. 2005. Research methods for social work. 5th ed. Australia: Thomson Brooks/Cole.

27. Schindler, D.R. & Cooper, P.S. 2001/2003. Business Research Methods. Seventh/Eight Edition. New York, NY. McGraw-Hill.

28. South African National Roads Agency Limited. 2014. SANRAL engages with the business community of Limpopo. Available online: http://www.nra.co.za/live/content.php?Session_ID=166165b7aa52b4707e8fa9b093b22ca2&Item_ID=4826

29. South African National Roads Agency Limited. 2017. Hello Gauteng. Available online: http://www.nra.co.za/content/SANRAL-Hello-GAUTENG-2017~3.pdf.

30. Statistics South Africa. 2016. Media release: Limpopo community survey 2016 results. Available online: http://www.statssa.gov.za/?p=7988.

31. Wegman, F., Aarts, l. & Bax, C. 2007. Advancing sustainable safety: National road safety outlook for 2005–2020. Leidschendam, The Netherlands: Institute for Road Safety Research.

32. World Economic Forum. 2015. How far do roads contribute to development? Available online: https://www.weforum.org/agenda/2015/12/how-far-do-roads-contribute-to-development/.