

SAFETY EFFECTS OF COMBINED ROAD ALIGNMENT ON DRIVERS' PERCEPTION ERRORS

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INTRODUCTION

- Road safety is a growing concern because of increase in number of road collisions.
- Every year, 1.2 million people die in road accidents and million and others sustain injuries, with some suffering permanent disabilities (WHO, 2004).
- According to Singini (2018), Nkhata-Bay Police station registered 21 accident cases on newly rehabilitated M5 road.
- Many studies have indicated several causative factors including negative perception of drivers on the road, complex alignment of the road, incorrect interpretation of the road signs, absence and inaccurate positioning of road signs (Cartes, 2002; Hoc et al 2005; Bella and Russo, 2012).

PROBLEM STATEMENT

- Previously, the Mzuzu-Nkhatabay M5 road experienced frequent accidents due to road narrowness, poor visibility and absence of shoulders which called for rehabilitation with minor improvements on existing curves.
- However, there has been an increase in road accidents on the newly rehabilitated road (Singini, 2018).
- For instance, road accidents rose from 8 in 2016 (before rehabilitation) to 21 in 2020
- No study had been conducted to assess the factors leading to increased accidents on Mzuzu-Nkhatabay M05 road
- Therefore, this study sought to find the factors leading to increased road accidents on M5 road by analysing drivers' behavior and combined road alignment on M5 road between Mzuzu and Nkhata-Bay.

STUDY OBJECTIVES

➤ **Main objective**

The main aim of this study was to assess the road safety effects of combined road alignment on drivers' perception errors in Nkhata bay

➤ **Specific objectives**

1. To assess the coordination between vertical and horizontal alignment of the road on drivers' speed behavior
2. To assess drivers' perception of the symbolic road signs that indicate a hazardous bend on the Mzuzu-Nkhatabay M5 road

RESEARCH HYPOTHESES

- H_0 = Different vertical curve combinations do not affect drivers' speed behaviour
- H_0 = Symbolic road signs on complex alignment do not increase drivers' perception errors

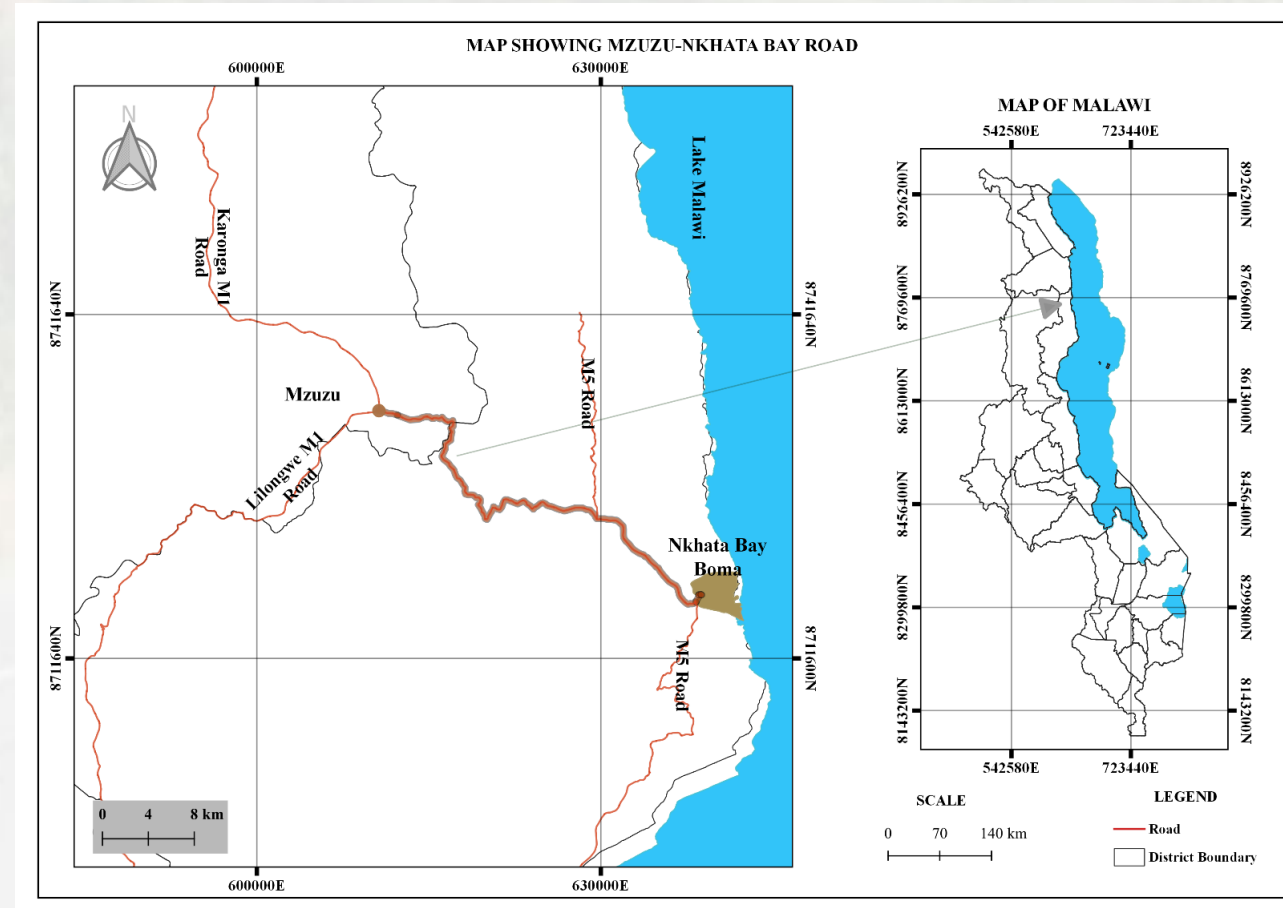
SIGNIFICANCE OF THE STUDY

- The significant impact of the study lies in its ability to identify the root causes of road accidents, focusing on the interplay between road design, vehicle conditions and driver behavior.
- To the GIS and Open Mapping, the study contributes the following;
- **Enhanced Road Signage Analysis:** The use of GIS in assessing the accuracy and adequacy of road signage highlights how spatial analysis can be used to improve the positioning and effectiveness of road signs, thereby enhancing driver awareness and safety.
- **Visualization and Public Awareness:** The study also sets out a vantage ground for incorporating Visual Road information about alignment into Open Maps, which can aid drivers in understanding road properties such as bend curvatures when driving.
- **Improving Road Safety Analysis:** The application of GIS in this study to analyze the collected data has revealed how engineers can also identify potential danger zones and areas prone to accidents using GIS based analyses.

METHODOLOGY

• Study site

- Mzuzu-Nkhatabay M5 road in Nkhata-Bay
- The road stretches over a 46 km distance from Mzuzu City to Nkhata-Bay district.
- The road got rehabilitated from 2013 to 2018



METHODOLOGY...

- **Sampling**

- Multistage sampling for road alignment- the alignment was firstly visualised as a whole and further visualisation was done specifically for areas with more curves and with few curves.
- Purposive sampling for questionnaires
- Purposive sampling for checklist

METHODOLOGY...

- **Data collection**

- Interviews – drivers, Road Traffic Police officers and Malawi Roads Authority Officials
- Field observations – road traffic signs positioning
- Road signage spatial data was collected using a handheld GPS receiver
- Road accident data from Malawi Road Traffic Police
- Mzuzu-Nkhatabay M05 road setting out data from Malawi Roads Authority

METHODOLOGY...

□ Data analysis

➤ Objective 1

- QGis version 3.4
- AutoCAD Civil 3D

➤ T- test using SPSS version 22

$$t = (\mu_1 - \mu_2) / S_d$$

➤ Objective 2

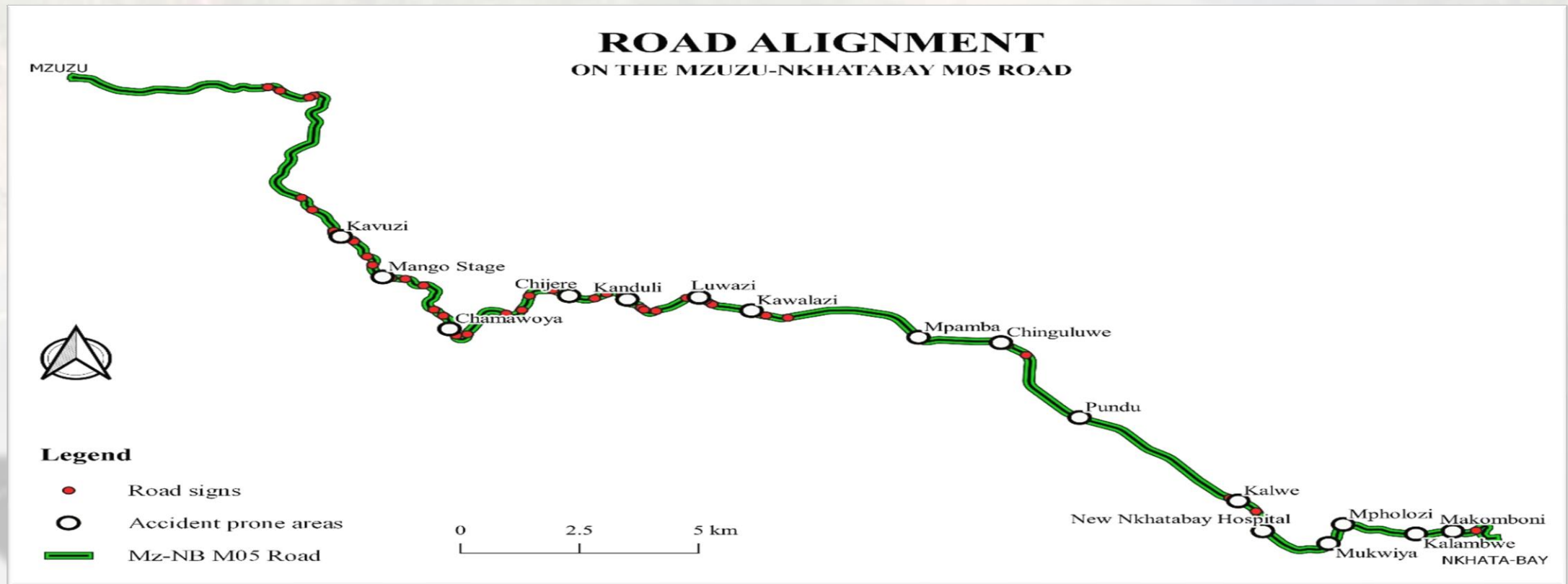
- T- test using SPSS version 22

$$t = (\mu_1 - \mu_2) / S_d$$

RESULTS AND DISCUSSION

Objective 1: vertical and horizontal alignment on drivers' speed behavior

- The analysis of the secondary data from RA was used to visualise the road alignment and direct observations shows that efforts were made during the rehabilitation to avoid sharp curves



Objective 1: vertical and horizontal alignment on drivers' speed behavior

- To understand the effects of vertical curve on drivers' speed behavior that accelerates road accidents, t-test was conducted on accidents records that resulted from over speeding on the two road stretches; one with more curves and the other with few

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Less Vertical Curves	3.15	20	3.977	.889
	More Vertical Curves	.75	20	1.482	.331

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Less Vertical Curves - More Vertical Curves	2.400	4.795	1.072	.156	4.644	2.239	19	.037

- Few vertical curves $M= 2.40$; $P= 0.037$
- **Complex combined road alignment does not increase drivers' perception errors**

Objective 1

- Adding to the t-test results on different road configurations, a paired sample t-test on the general accident trends before and after the rehabilitation of the road, revealed positive significant differences for 2018 and 2016, 2019 and 2016, and 2020 and 2016 (M=0.833; P=0.017, M=1.0; P=0.032, M=1.250; P=0.011, respectively)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 2017 Accidents record - 2016 Accidents record	.250	1.357	.392	-.612	1.112	.638	11	.536
Pair 2 2018 Accidents record - 2016 Accidents record	.833	1.030	.297	.179	1.488	2.803	11	.017
Pair 3 2019 Accidents record - 2016 Accidents record	1.000	1.414	.408	.101	1.899	2.449	11	.032
Pair 4 2020 Accidents record - 2016 Accidents record	1.250	1.422	.411	.346	2.154	3.045	11	.011

- These results show that there has been an increase in accidents after the rehabilitation of the road

Objective 1: vertical and horizontal alignment on drivers' speed behavior

- The current rehabilitated road reduces drivers speed error on different curves as they are able to judge correctly the desirable speed ranges on curves and necessitates drivers' clear sight distance and this is in agreement with Bella(2014) and Bella & Russo (2012).
- While the grade and radii of the road may be of good standard, absence or inefficient availability of road signs can compromise safety of new road users who may misjudge the terrain and apply none recommended speed on curves.
- As observed the rehabilitation has made sure that areas with complex alignment should have proper road signage, warning people of the alignment ahead and operating speed reduction.

Objective 2: drivers' perception of the symbolic road signs

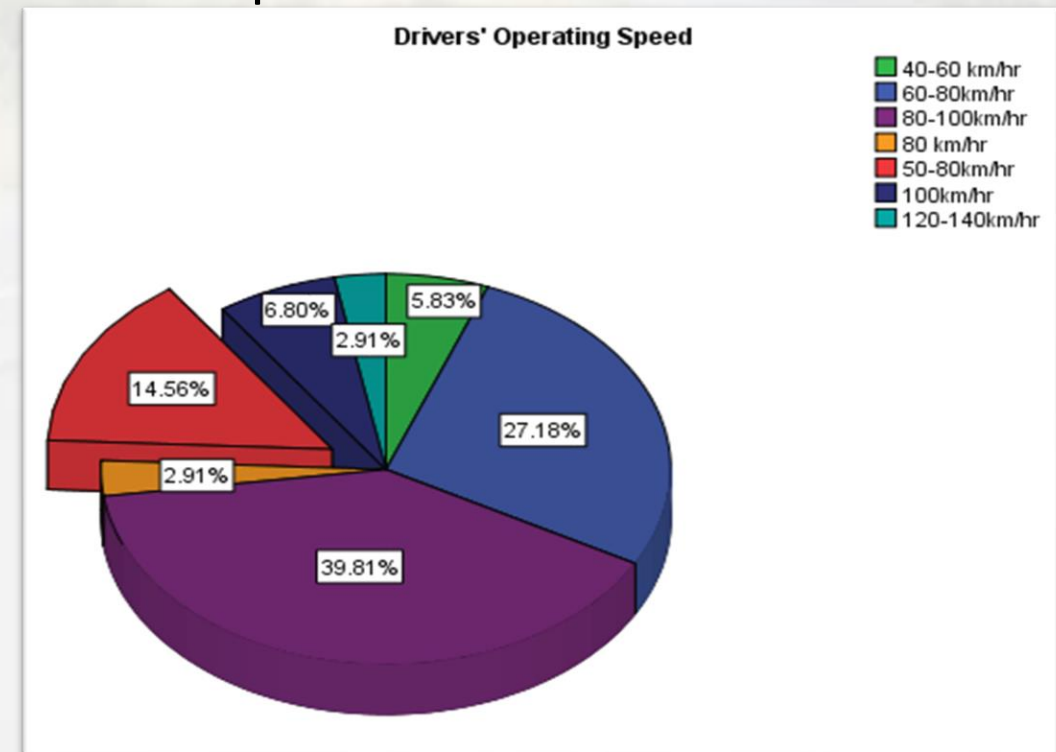
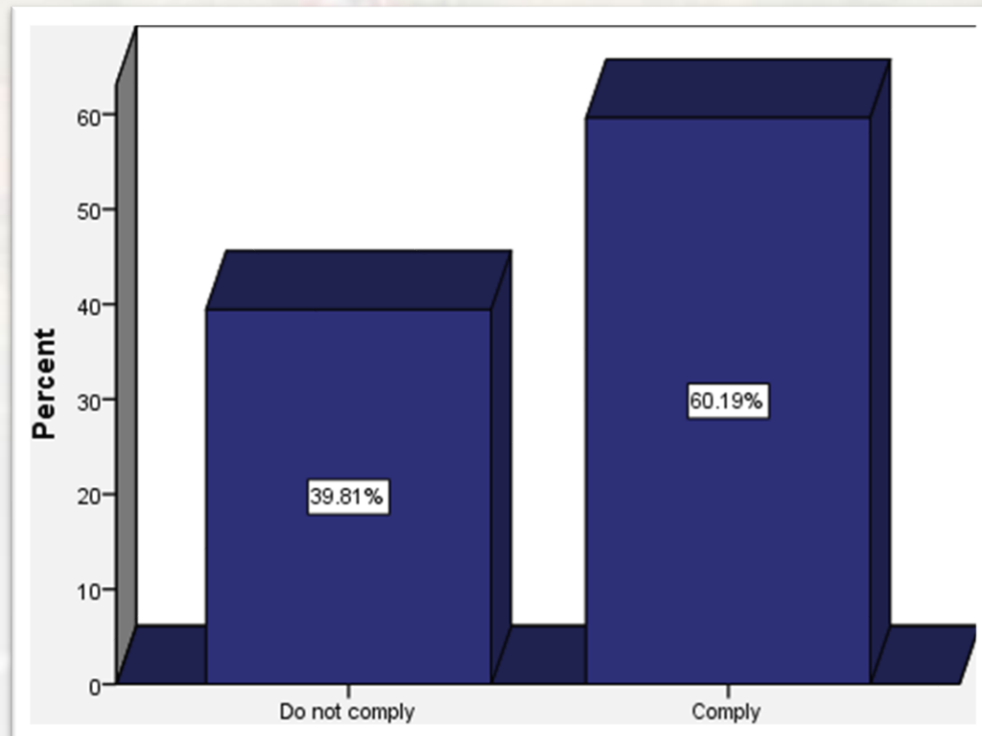
	N	Mean	Std. Deviation	Std. Error Mean
Mz-NB Observed Road Signs	8	5.00	1.690	.598

	Test Value = 10.25					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Mz-NB Observed Road Signs	-8.785	7	.000	-5.250	-6.66	-3.84

- Having divided the road length into 4 sections (8 sections for to and fro linear sections), each bearing 11.5 kilometers, the road signs population (84 expected) mean was found to be 10.25.
- Sample mean for the observed road signs was 5.00 which resulted into a significant mean difference of 5.250 ($P < 0.01$).

Objective 2 : drivers' perception of the symbolic road signs

- In addition to informing drivers about road hazards ahead, road signs provide instructions on how road users should operate.
- Drivers normally adjust their driving speed upon being informed of the nature of the road ahead.
- Therefore, although many of them (60.19%) claim to comply with the design speed, this might not be a true reflection of compliance.



Objective 2 : drivers' perception of the symbolic road signs

- It was also observed that despite most road signs having been omitted, some road signs are obscured by vegetation and poorly positioned



- These results concur with the findings of Isabel *et al* (2016) who also concluded that when road signs are poorly positioned and not in adequate numbers, drivers' perception errors increase, hence reducing their safety as they travel on the road.

CONCLUSION

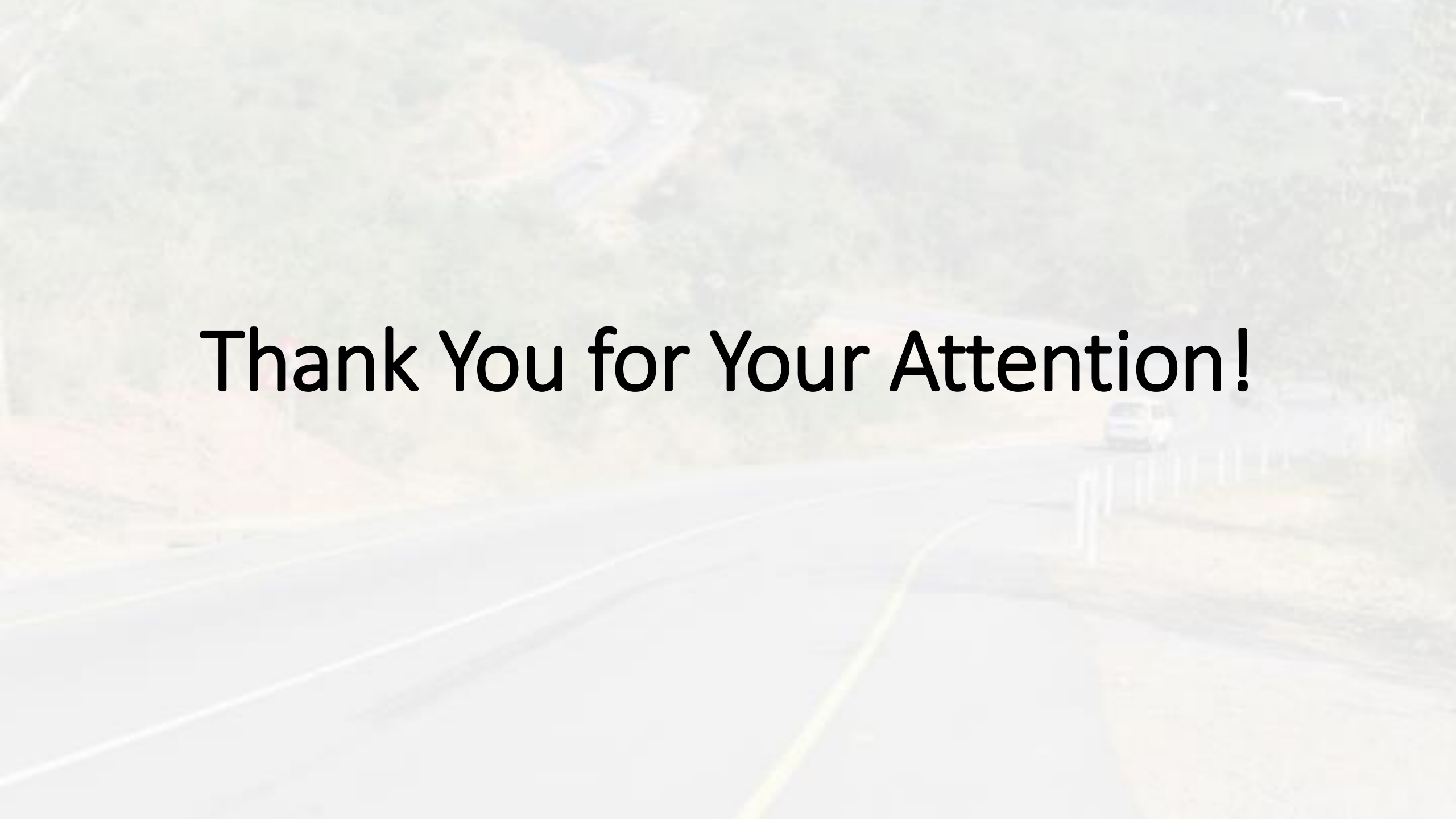
- The road alignment was designed according to standard and no evidence has been found that it significantly contributes to accident record increase
- There is inadequate evidence that different configurations of vertical curve combinations affect drivers' speed behavior that contribute to the rise of accidents on the rehabilitated road, rather inadequacy of road signs contributes to the rise
- However, drivers' speeding behavior contribute a lot to the increased accidents' rate.

RECOMMENDATIONS

- Based on the findings of this study, the researcher recommends that, to increase drivers' perception of hazardous bends on Mzuzu-Nkhatabay M05 road, more road signs should be added especially in sections with less complex alignment
- There is also a need to sensitize drivers on the recommended operating speed of the road as most of them have a wrong understanding on this subject.
- Sensitization should also be done on pedestrians especially those located along the road as most of them are seen crossing and vending along the road without following road instructions
- For open street mappers and spatial analysts, road configurations information should be included in road maps to enhance drivers' understanding of road properties

Acknowledgements

- Nkhatabay Traffic police
- Malawi Roads Authority
- MUBAS (LS and PP department)

The background is a blurred photograph of a road. The road is paved and has a yellow center line and white edge lines. On the right side of the road, there is a metal guardrail. In the distance, a white car is visible on the road. The overall scene is out of focus, with a soft, hazy atmosphere.

Thank You for Your Attention!