Presentation Title: Crash Data Analysis & Prediction in Zimbabwe: An Application of ARIMA Models

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PRESENTATION OUTLINE

a. Introduction
b. Methodology
c. Results
d. Recommendations & Conclusion

INTRODUCTION

Overview of the Road Safety Situation Around the Globe

- Globally, each year nearly 1.3 million people die as a result of a road traffic crash;
- More than 3000 deaths each day—and more than a half of these people are vulnerable road users: pedestrians, cyclists, and motorcyclists.
- 20 to 50 million more people sustain non-fatal injuries from a crash. These injuries are an important cause of disabilities worldwide.
- 90% of road traffic deaths occur in low and middle-income countries, which owns about 54% of the world's vehicles.
- Road crash costs African countries 1-5% of their Gross Domestic Product (GDP) every year.

INTRODUCTION

Road Traffic Crash Situation in Zimbabwe

- Road traffic collision every 5 minutes
- About 5 people die every day
- +/-2000 fatalities per year
- Most collisions occurring during the day: 0600hrs – 1800hrs
- Zimbabwe loses about 406 million United States Dollars annually due to road carnage

INTRODUCTION

- Major risk factors explaining why we still have significantly high RTCs include:

i. Speeding
ii. Drinking and driving
iii. Overtaking error
iv. Turning error
v. Inattention or misjudgment
vi. Vehicle defects
vii. Poor weather conditions
viii. Animals

INTRODUCTION

- Despite the growing burden of road traffic crashes, crash data analysis and prediction has received insufficient attention at both the international and national levels.
- This study is envisioned to go a long way in helping the Government of Zimbabwe in planning ahead and mobilizing enough resources to fight road carnage in the country.

INTRODUCTION

Objectives

i. To analyze crash trends in Zimbabwe over the study period.

ii. To develop and estimate a reliable road traffic crash prediction model/(s) for Zimbabwe based on the Box-Jenkins ARIMA technique.

iii. To project road traffic crashes (case volumes, deaths and injuries) in Zimbabwe over the next 5 to 10 years.

METHODOLOGY

The Autoregressive Integrated Moving Average (ARIMA) Model

- The Autoregressive (AR), Moving Average (MA) and the Autoregressive Moving Average (ARMA) processes are normally not applied empirically due to the fact that in most cases many time series data are not stationary; hence the need for differencing until stationarity is achieved.

When the actual data series is differenced "d" times before fitting an ARMA (p, q) process, then the model for the actual undifferenced series is called an ARIMA (p, d, q) model as follows:

$$\emptyset(B)(1-B)^d X_t = \theta(B)Z_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

- The Box – Jenkins technique was proposed by Box & Jenkins (1970) and is widely used in many forecasting contexts, including Transport Economics.

METHODOLOGY

- The researchers used secondary data on road traffic crash case volumes, deaths and injuries.
- All the data was gathered from the Zimbabwe National Statistics Agency (ZimStats) head office in Harare and covers the period 1997 to 2021.
- The E-Views version 12 software (automatic ARIMA forecasting option) was used for data analysis.

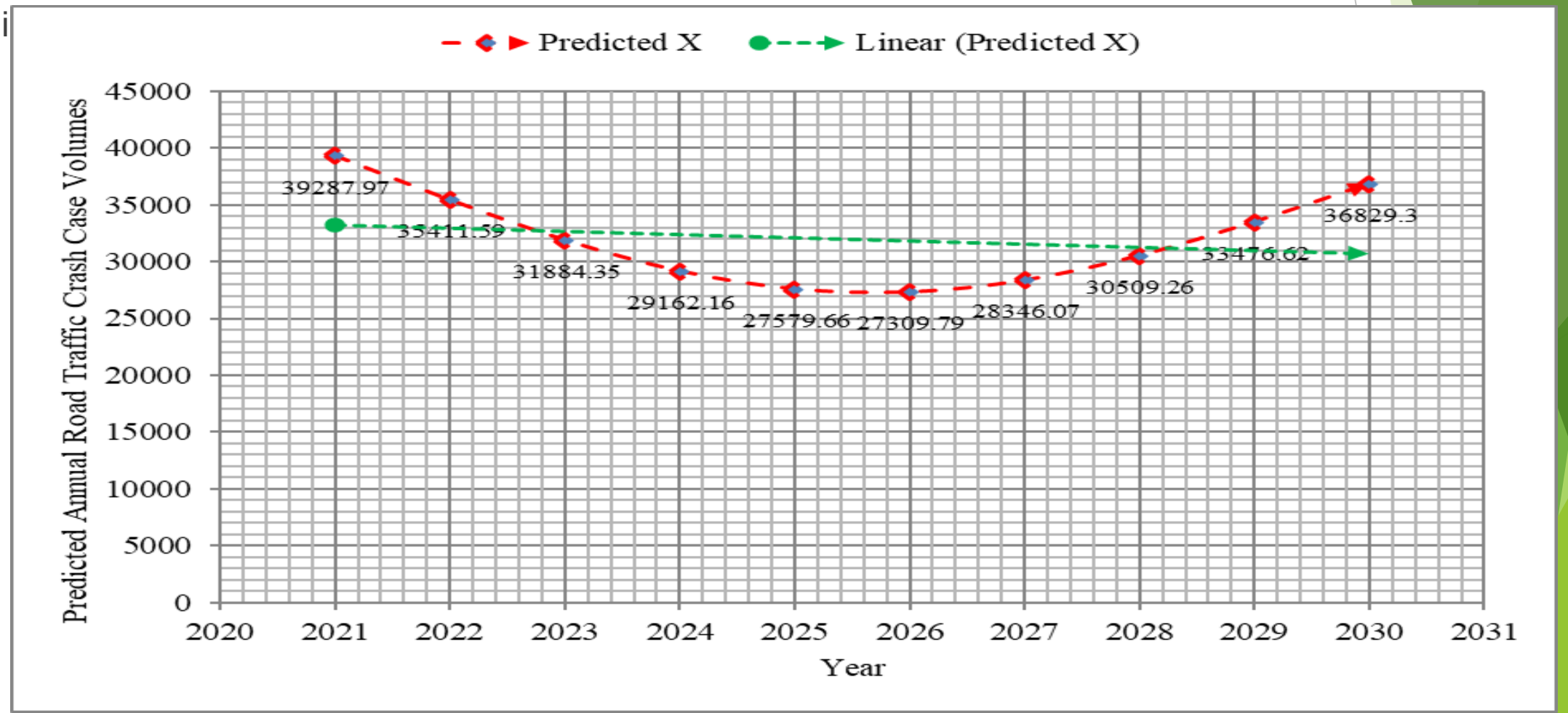
METHODOLOGY: Evaluation of Various ARIMA Models

Table 1 Evaluation of ARIMA models

Dependent Variable	Level of Stationarity	Selected ARIMA Model	AIC Statistic
Annual Road Traffic Crash Case Volumes	I(0)	(2,0,2)	21.691095
Annual Road Traffic Crash Deaths	I(0)	(2,0,1)	15.414182
Annual Road Traffic Crash Injuries	I(1)	(0,1,1)	20.122647
Quarterly Road Traffic Crash Case Volumes	I(0)	(1,0,0)	18.256877
Quarterly Road Traffic Crash Deaths	I(0)	(0,0,0)	11.865250
Quarterly Road Traffic Crash Injuries	I(0)	(1,0,2)	15.239705

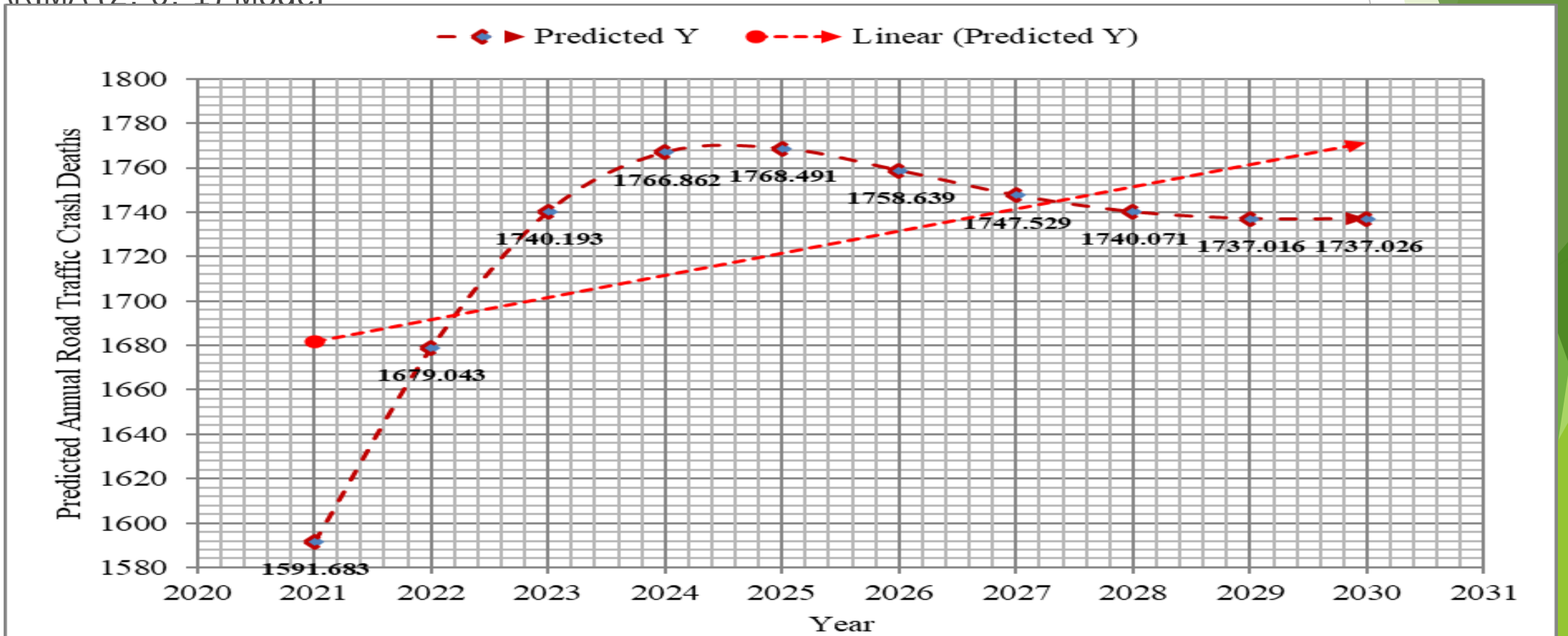
RESULTS

Fi


Predicted X
Linear (Predicted X)
Predicted Annual Road Traffic Crash Case Volumes
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
39287.97
35411.59
31884.35
29162.16
27579.66
27309.79
28346.07
30509.26
33476.62
36829.3
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
Year

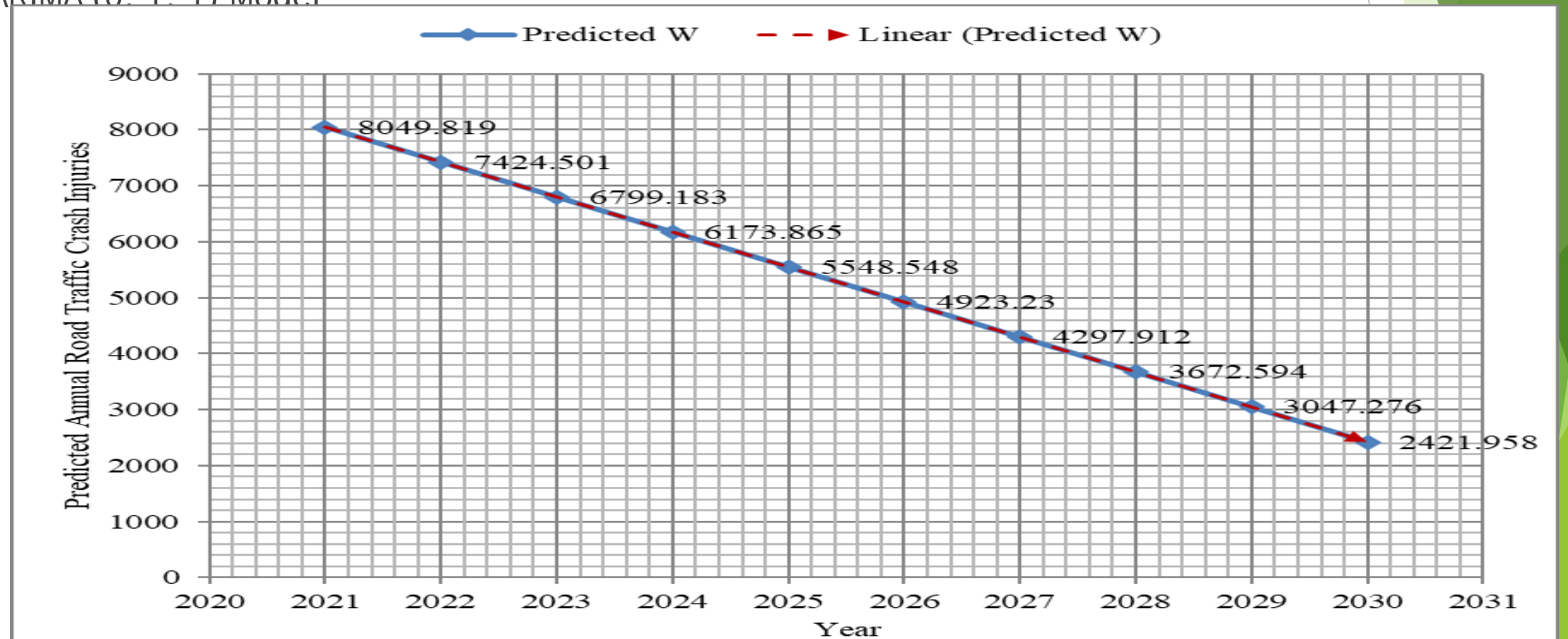
RESULTS

Figure 2: Graphical Presentation of the Out of Sample Forecasts of the of the ARIMA (2, 0, 1) Model



RESULTS

Figure 3: Graphical Presentation of the Out of Sample Forecasts of the of the ARIMA (0, 1, 1) Model



RESULTS

Table 2: Presentation of the Out of Sample Forecasts of the of the quarterly crash data sets under consideration

Period	Predicted Quarterly Road Traffic Crash Case Volumes	Predicted Quarterly Road Traffic Crash Deaths	Predicted Quarterly Road Traffic Crash Injuries
December 2021	11 539.22	417.6957	2 239.312
March 2022	11 529.27	417.6957	2 390.766
June 2022	11 524.71	417.6957	2 423.203
September 2022	11 522.63	417.6957	2 448.052
December 2022	11 521.68	417.6957	2 467.088
March 2023	11 521.25	417.6957	2 481.670
June 2023	11 521.05	417.6957	2 492.841
September 2023	11 520.96	417.6957	2 501.398
December 2023	11 520.91	417.6957	2 507.954
March 2024	11 520.90	417.6957	2 512.976
June 2024	11 520.89	417.6957	2 516.823
September 2024	11 520.88	417.6957	2 519.770
December 2024	11 520.88	417.6957	2 522.027
March 2025	11 520.88	417.6957	2 523.757
June 2025	11 520.88	417.6957	2 525.082
September 2025	11 520.88	417.6957	2 526.097

RECOMMENDATIONS

The Government of Zimbabwe should:

- Make sure that road safety is one of the country's major political priorities;
- With the help from the Zimbabwe Republic Police (ZRP), enforce safe driving practices;
- Install and maintain appropriate road signs on new and existing roads;
- Ensure the installation of visible road markings and signs that are less prone to vandalism;
- Support the creation of road safety advocacy groups;
- Through the Road Traffic Act, strictly enforce legislation requiring the use of seat-belts and child restraints, adherence to appropriate speed limits, preventing alcohol-impaired driving and the wearing of motorcycle helmets and bicycle helmets;
- Set and enforce strict and uniform vehicle safety standards.

THE END

Acknowledgement

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Thank you!!!