FORECASTING ROAD ACCIDENTS IN MALAYSIA

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Abstract

Road accidents are serious and unresolving issue in Malaysia. Road accidents increase rapidly since the year 2011 due to increase in mobility, transportation and population growth. The goal of this study is to forecast road accidents for the year 2023 and 2024 based on Malaysian road accident historical data from the year 2011 to year 2019. Accident data for the year 2020 and year 2021 were not included in the analysis since the data is insufficient due to COVID pandemic. The analysis includes road accidents forecast by accident severities, states and accident contributing factors. Three states with highest accident numbers and top three accident contributing factors were involved in analysis to observe the future accident trend. The accident forecasts were forecasted with Autoregressive Integrated Moving Average (ARIMA) method using the R statistical software. The results indicated that accidents due to damage increases in line with the total number of accidents for the years to come compared to decreasing number of accidents for death, serious injury and minor injury. The number of road accidents for Selangor, Kuala Lumpur and Johor shown increasing trend. Accident due to run off-road increases while accidents due to sideswipe and overtaking depicted decreasing trend. Moving forward, this study may contribute to road safety with the reduction of number of death due to road accidents by 2030 which is estimated to decrease by 50%.

Keywords: ARIMA, Forecasting, Road accident, Transportation.

1. Introduction

Road accident occurs almost every day. After cerebrovascular disease, pneumonia, and ischemic heart disease, road accidents are the fourth leading cause of death in Malaysia. According to the Malaysian Department of Statistics [1], number of road accidents in year 2019 increased by 79% since the year 2011. This study explored the trend of road accidents in Malaysia over a 9-year period, from year 2011 to year 2019. This study focuses on using ARIMA model in predicting the road accidents in Malaysia for the next five years, from the year 2020 to year 2024. Road safety and transport authorities in Malaysia have taken initiatives to reduce the number of road accidents due to death and serious injuries. Implementation of Road Safety Plan 2014-2020 by MOT in line with Sustainable Development Goal Plan 3.6 to reduce half the number of global deaths and injuries from road traffic accidents by 2020, and Sustainable Development Goal Plan 11.2 to provide access to safe, affordable, accessible, and sustainable transport systems besides improving road safety. The execution of the plan has shown some successful results in reducing severe accidents especially the death by 50% [1].

Human factor is regarded as the main contributor to road accidents. Human factor accounts for approximately 94% of road accidents [2, 3]. Driving under the influence of alcohol, sleepy, distraction and under influence of drugs increase the risk of accidents towards death and serious injuries [4]. On the other hand, accidents are caused by the road defects, weather condition, vehicle issue and environmental factors [5]. Time-series method introduced by Box and Jenkins [6] were used for forecasting road accidents in which Autoregressive Integrated Moving Average (ARIMA) model is the most used technique for accident forecast [7]. Therefore, this paper is prepared to study the trends, patterns and forecast of road traffic accidents in Malaysia.

2.Methodology

This study includes road accidents taken for entire Malaysia. The road accident data were published by the Royal Malaysian Police. Historical accident data from year 2011 to year 2019 were used as the input to project 5 years of accident [1]. Moving forward, accident forecast for the year 2023 and 2024 are the focus of this study. The number of accidents by state/territory, by accident severities and by causes of accidents are among the information used in this study. Top three accidents contributing state/territory and top three accident causes were forecasted in this study with the intention to reduce accidents from the states and accident causes which highly contribute to accidents. The first-order autoregressive (ARIMA) method was used for accident forecasting.

The ARIMA approach is based on the linear functions of the data observed with fewest parameters. The acronym ARIMA stands for Auto-Regressive Integrated Moving Average. A nonseasonal ARIMA model is classified as an "ARIMA(p,d,q)" model, where p is the autoregressive parameter, d is the degree of differencing parameter and q is the moving average parameter.

The AR(1) or first-order autoregressive model equation were obtained as shown in Equation 1 whereby c and φ_1 represent constants, while e_t represents a random error at time t.

$$Y_t = c + \varphi_1 Y_{t-1} + e_t \tag{1}$$

In this regression model, the response variable in the previous time period has become the predictor and the errors have the usual assumptions about errors similar to a simple linear regression model. The order of an autoregression is the number of immediately preceding values in the series that are used to predict the value at the present time. So, the preceding model is a first-order autoregression, written as AR(1).

The ARIMA method chosen for this modelling is random walk model whereby the Y is not stationary in which has no autoregressive nor moving-average terms and modelled using first-degree difference. Since random walk model includes a first degree difference and a constant term, it is classified as an "ARIMA(0,1,0) model with constant".

3. Results and Discussion

Figures 1 to 5 show the number of accidents with regards to accident severities and total accidents by year. The accident severities encompassed the death, serious injury, minor injury and damage accidents. Accidents which contributed to death, serious injury and minor injury in Figs. 1 to 3 shows decreasing trendline, however the accidents due to damage in Fig. 4 increases in line with the total accident numbers.

Based on the forecasted results, the accidents related to death is still high in 2024 estimated about 5400 accidents whereas major reduction in serious injury and minor injury were noticed to be reduced close to 1000 accidents. Accidents due to vehicle damage only were observed to be steeply increase about 100000 in the year 2024. This shows that the efforts and initiatives taken by the ministry and relevant highway authorities imposing the accident safety plans managed to reduce accidents involving death, serious injury and minor injury. However, the accident due to damage is difficult to control since it involves human error such as misjudgement in overtaking, run off-road and sideswipe. From the prediction values and the graph, it can be observed that, accident cases in Malaysia will continue to increase in the next coming years.
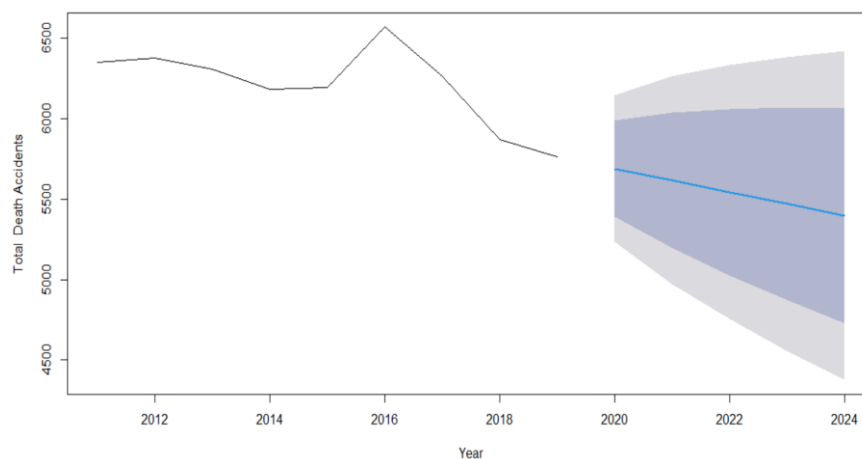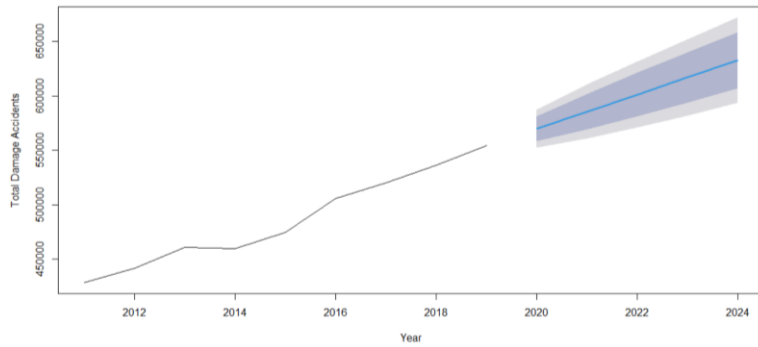

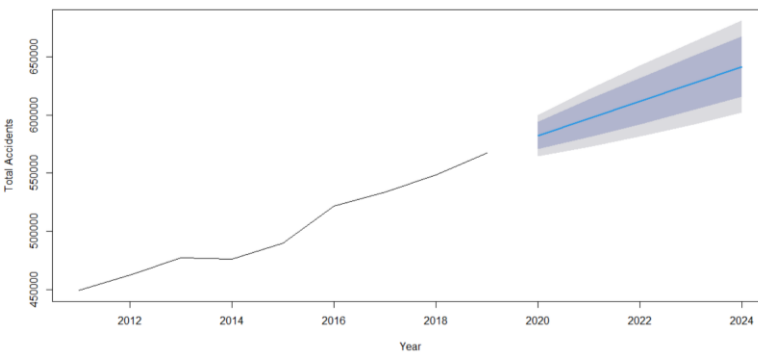**Fig. 1. Forecasted total fatal accident.**
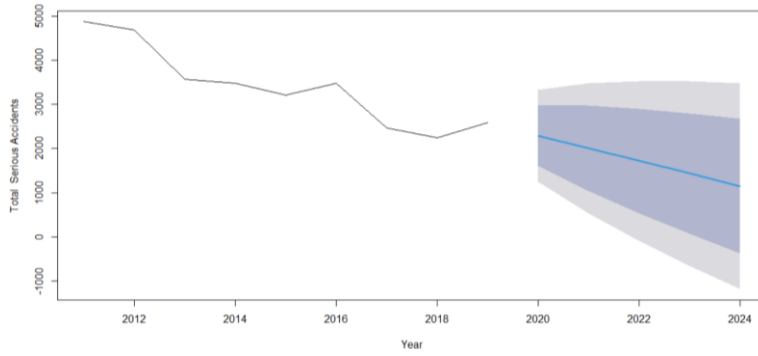
Fig. 2. Forecasted total serious accident.
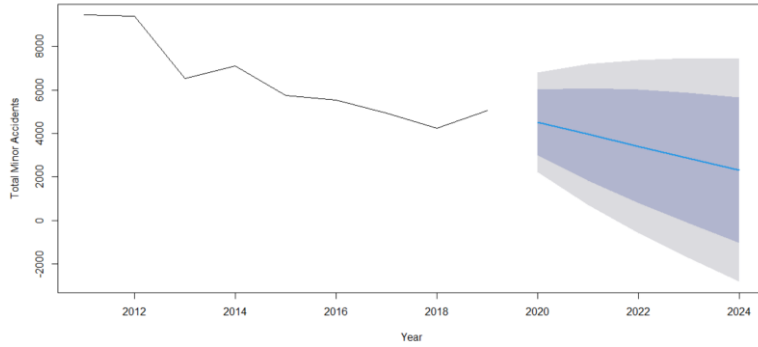


Fig. 3. Forecasted total minor accident.

**Fig. 4. Forecasted total damage accident.**

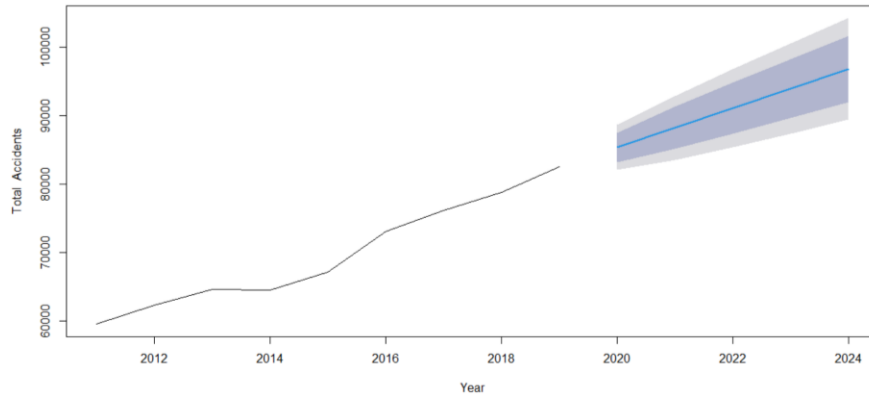**Fig. 5. Forecasted total road accident.**

Figures 6 to 8 depict road accidents trendline for the state of Selangor, Kuala Lumpur and Johor territory. Selangor, Kuala Lumpur and Johor are the top three states/territory with the highest number of road accidents which contributed to the increase in total accidents numbers in Malaysia from year to year. The forecasted results for all three states indicated increasing trendline for the year 2023 and year 2024. Referring the forecasted results, Selangor has higher number of accidents and in year 2024, the total accidents could reach up to 200000 accidents. The numbers are quite alarming especially in the developed states whereby majority of accidents takes places during peak hours and also with the involvement of motorist as major contribution towards accidents. The increase in accidents could possibly be due to several reasons including the rapid growth in term of vehicle ownership, highly populated state, many dense area, increased road network, vast development, extensive road expansion works and high traffic demand.
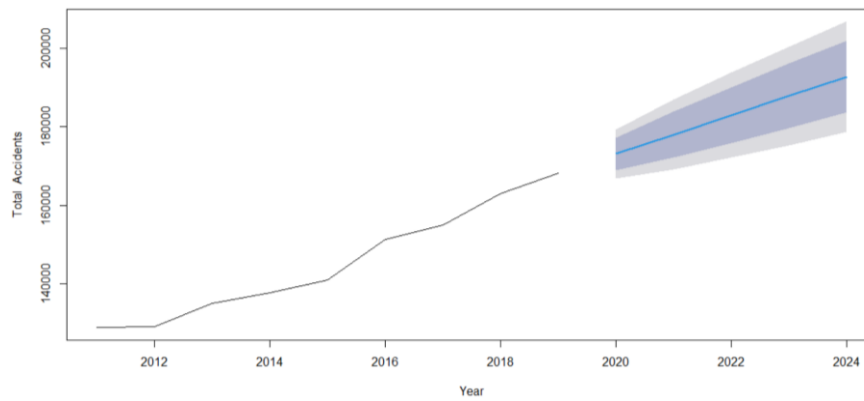
**Fig. 6. Forecasted fatal accident for Selangor.**
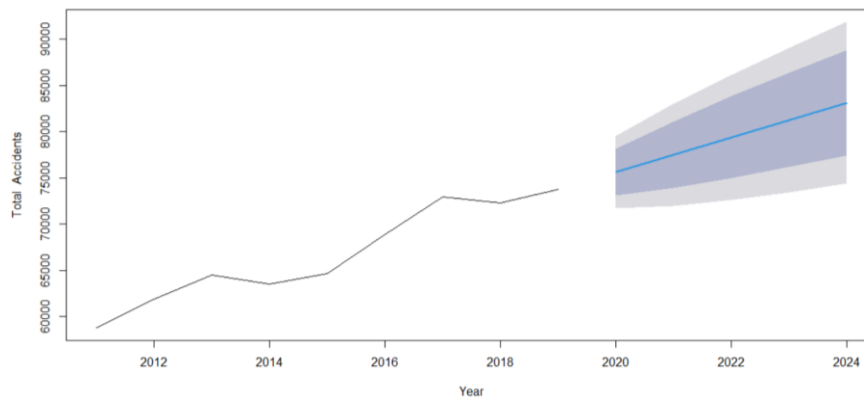
**Fig. 7. Forecasted fatal accident for Kuala Lumpur.**

Fig. 8. Forecasted fatal accident for Johor

Figures 9 to 11 show the accident contributing factors towards road accidents according to years. Accidents due to run off-road, overtaking and sideswipe are the three major factors contributed to road accidents. Accidents related to run off-road projected to increase over the years while sideswipe and overtaking accidents predicted to decrease in the coming years. The number of accidents related to run off-road is very much higher than the sideswipe accidents and overtaking accidents. In year 2024, it is forecasted that the number of accidents due to run off-road would increase up to 2500 cases compared to 2200 cases in year 2022. Accidents subjected to run off-road could possibly cause by the human error such as speeding, distraction, fatigue, microsleep, less attention and caused by external factor such as worn-out car tyres, weather, road condition and environmental effects. However, the number of accidents due to sideswipe and overtaking are projected to reduce slightly from year 2022 to 2024. Reducing accident numbers of both sideswipe and overtaking has been noticed since the year 2011 which is a good indication that government safety plan has successfully accomplished.
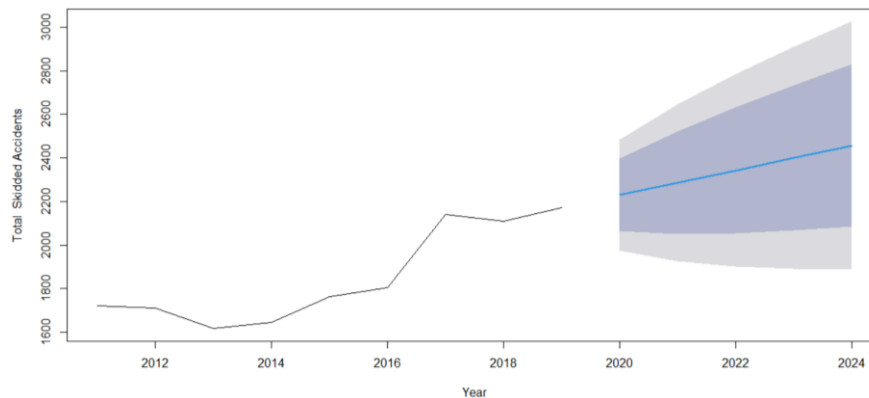
Fig. 9. Forecasted road accident involve in run off-road.
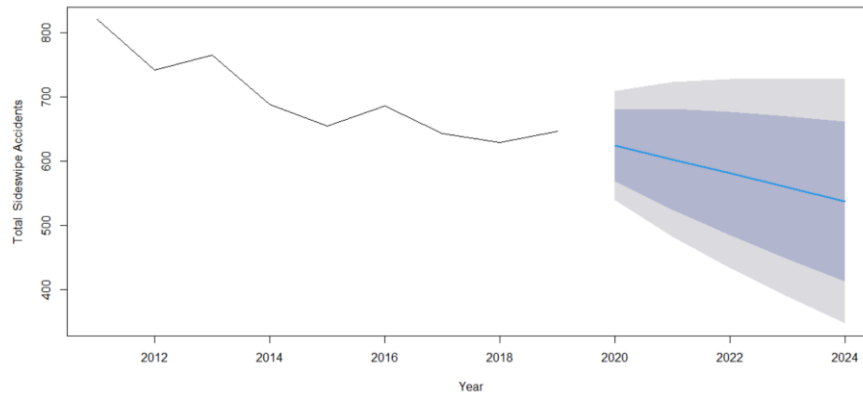
Fig. 10. Forecasted road accident involve in sideswipe.
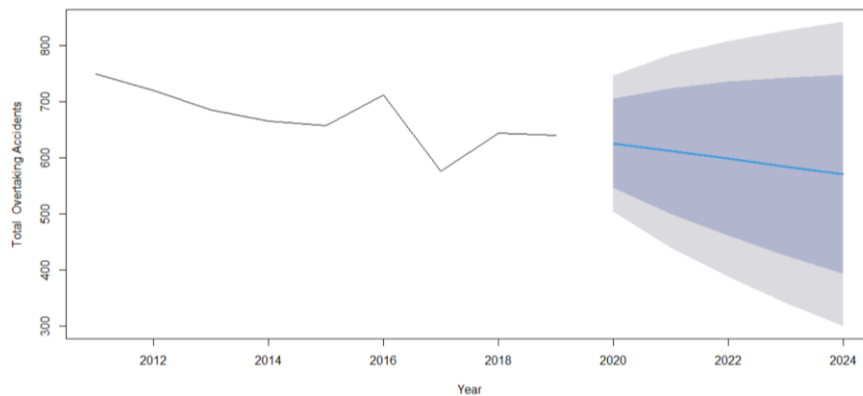
Fig. 11. Forecasted road accident involve in overtaking.

4. Conclusions

ARIMA model was identified suitable to forecast accident trend in Malaysia [8, 9]. This study revealed that the total number of accidents especially the number of accidents for due to vehicle damage only, number of accidents in Selangor, KL and Johor, accidents due to run off-road continue to increase over the years. The findings of this study draw attention to the importance of implementing road safety measures to reduce the number of accidents in the country. Future studies are needed to observe if the total road accidents can be reduced with the implementation of current road safety plan 2022-2030 by the Ministry of Transportation (MOT), Malaysia.

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