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Road Traffic Collision: Reasons and the Future

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Abstract:
This paper focuses on identifying the determinants of Road Traffic Collision (RTC) and forecasting the number of RTC in Malaysia for the next ten years. The correlation test employed 15 years' data on RTC, population, gross domestic product (GDP), new drivers, and registered vehicles that were collected from JKJR and World Bank Group. SPSS software enabled to determine through Pearson's product-moment correlation whether population, registered vehicles, GDP, or new drivers were RTC determinants in Malaysia. The overall results showed that registered vehicles, population and gross domestic product (GDP) were the main determinants of RTC; motorcycle accidents attained the highest rank of injured RTC, while bus accidents were ranked as the lowest RTC causing injuries and death. The number of RTA fatalities was observed to decrease by 0.82% each year for the following ten years, with 5588 expected RTA fatalities in 2029. The government was alarmed, and concerns arose due to the apparent fact that RTC is increasing fast. In 2018, 6,284 people were killed in RTCs. Henceforth, a reduction in the number of RTCs is urgently required. This study recognized the pattern of road accidents in Malaysia and gave some measurements to avoid severe accidents. The intervention of method was proposed to ensure the the reduction of road accident percentage. The results help the government reduce the number of such fatality cases and take the necessary actions for mitigation plans.

Keywords: road traffic collision, determinant, Pearson's product-moment correlation, forecast, auto-regressive integrated moving average.

道路交通碰撞：原因与未来

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摘要:
本文的重点是确定道路交通碰撞（实时时钟）的决定因素，并预测马来西亚未来十年的实时时钟数量。相关性测试使用了从 JKJR 和世界银行集团收集的 15 年关于实时时钟、人口、国内生产总值（国内生产总值）、新司机和注册车辆的数据。SPSS 软件能够通过皮尔逊的产品时刻相关性确定人口、注册车辆、国内生产总值或新司机是否是马来西亚实时时钟的决定因素。总体结果表明，注册车辆、人口和国内生产总值（国内生产总值）是实时时钟的主要决定因素；摩托车事故在受伤实时时钟中排名最高，而公共汽车事故在造成伤害和死亡的实时时钟中排名最低。据观察，在接下来的十年中，区域贸易协定死亡人数每年下降 0.82%，预计 2029 年将有 5588 人死亡。政府感到震惊，并且由于实时时钟快速增长的明显事实而引起了担忧。2018 年，有 6,284 人在实时时钟中丧生。此后，迫切需要减少实时时钟的数量。这项研究认识到马来西亚的道路事故模式，并提供了一些措施以避免严重事故。提出了干预方法，以确保降低道路事故百分比。结果有助于政府减少此类死亡病例的数量，并为缓解计划采取必要的行动。

关键词：道路交通碰撞，行列式，皮尔逊积矩相关，预测，自回归综合移动平均。

1. Introduction

Malaysian road traffic accident (RTA) fatality previous data showed no constant turn in the trend of RTA fatality; when there was a decrease in RTA fatality, the number climbed back a few years later. In a day, an average of 19 persons died from RTA in Malaysia. Malaysia was ranked as one of the top three countries with the highest RTA fatality rate in Asia, after Thailand and Vietnam (Alfaki, 2013). The consequence of RTAs has affected the provision of health care with the occupation of an insufficient number of beds and resource utilization, leading to loss of productiveness, earnings, and economic impact. The costs of loss can be categorized into two components: frequency and severity.

Road safety is considered a part of actuarial risk (Chang and WANG, 2006). Cohen and Dehejia (2004) recognized a climb in life insurance claims starting in 2012.

This study will focus on RTA fatality in Malaysia, which may benefit the government, civilians, and insurers from the trends and forecasts to overcome specific issues that lead to fatal RTA in Malaysia. Thus, two research objectives had been constructed for this study:

1. To investigate the ranking of different means of transportation in road traffic accident fatality in Malaysia.
2. To forecast the frequency of road traffic accident fatalities in Malaysia.

1.1. Fatal Road Traffic Accidents According to Means of Transportation

The World Health Organization (WHO) estimates that RTAs pose a major yet neglected public safety threat with an estimated 1.2 million people killed, 50 million seriously, and a large number of these RTAs and deaths were pedestrians, with 40 percent of fatalities in some countries. The most important factor affecting the magnitude of the disaster was the type of vehicle (Hartwig et al., 2016). In 1995, motorcyclists in Malaysia contributed 59% to RTAs death and serious injuries compared to the other road users; meanwhile, the second-highest of RTAs fatality were pedestrians with 12%, and bicycle riders had the least number of road death of 5% (Kareem, 2003).

1.2. Aftermath of Road Traffic Accident Fatalities

In recent years, studies have documented the effect of road traffic on car insurance. Insurers were given the full trust of the insured to protect them from unforeseen risks. Therefore, the insurers' duty was to provide the best insurance coverage (Liu and Sharma, 2006). Traffic collisions have exceptionally large prices, which are of great interest to economists (Lum, 2019). Driver conduct and danger attributes of the insured are also linked to auto insurance rates (Rohayu et al., 2012). The main results of a recent report released by the World Bank in 2017 show that road traffic accidents and injuries by half may boost the economy and lead to substantial long-term gains in developed countries. In certain situations, it may potentially contribute 7 to 22 percent of gross domestic product (GDP) per capita for 24 years and dramatically raise social security benefits.

1.3. Research Background

Vilaça et al. (2017) conducted a statistical examination to evaluate the severity and occurrence of road accidents associated with road users. This investigation established various relationships of accident situations, developments, improvements in road safety standards, and new policies related to traffic safety. Considering new variables such as weather conditions, specific locations, and singularities that might represent an additional risk, the evolution of the number of crashes is computed to create patterns of risk factors.

Regarding the predictive performance of RTA, Schlögl et al. (2019) compared a chain of statistical analysis techniques to derive the influential factors correlated with road accident occurrence. It is

confirmed that a trade-off between sensitivity and accuracy is fundamental to variance classification problems. The analysis highlighted the advantages of using high-resolution data in the framework of road accident analysis.

In finding the correlation between road fatalities and shuttle distance traveled by various transport modes, an ecological regression model was constructed by Goel (2018) to measure the fatalities. The case study involving an Indian state helped interface numerous modes on Indian roads and their approximate results related to road accidents.

Venkatraman et al. (2020) used the Friedman method to investigate how holidays affect weekly and daily traffic volumes. On the other hand, Zinn (2019) also used the Friedman test for a variable without distribution.

1.4. Methodology Review

Data on RTA, RTA fatality, registered vehicles, and the population were gathered from the JKJR official website, while Malaysian GDP data were obtained from the World Bank Group. Yearly data from 2005 until 2019 (15 years' data frequency) from JKJR and World Bank Group were used to compute correlation values. This test was carried out using SPSS software.

The Friedman test was used to identify the rank of RTA fatality according to the means of transportation and estimate significant differences among distributions at multiple observation periods.

Previous studies applied the Friedman method, especially when the dependent variable is ordinal and research requires no normality. The Friedman method was used by Liu and Sharma (2006) to investigate how holidays affect weekly and daily traffic volumes. On the other hand, the Friedman test is also used when a variable without distribution is present.

According to Parvareh et al., (2018), RTA incidence from March 2009 to February 2015 was simulated using the Box-Jenkins Time Series Model, utilizing the ARIMA and the Seasonal Autoregressive Integrated Moving Average (SARIMA) to estimate accidents up to 24 months later. In the meantime, Rohayu et al. (2012) conducted a study on RTA fatality, ARIMA (0, 1, 1) was found to be the best model, and fatal RTAs were forecasted to rise continuously.

2. Materials and Method

RTA incidence from March 2009 to February 2015 was simulated using the Box-Jenkins Time Series Model, utilizing the ARIMA and the Seasonal Autoregressive Integrated Moving Average (SARIMA) to estimate accidents up to 24 months later (Goel, 2018). In a study conducted by Rathakrishnan et al. (2022) on RTA fatality, ARIMA (0, 1, 1) was the best model, and fatal RTAs were forecasted to rise continuously. Fifteen years' data of RTC, population, gross domestic product (GDP), new driver, and registered vehicles were collected from JKJR and World Bank Group to test for correlation. Using SPSS software, Pearson's product-moment correlation was used to determine whether population, registered vehicle, GDP, and new driver were determinants of RTC in Malaysia.

3. Findings

The Friedman test was conducted to rank different means of transportation in road traffic accident fatality in Malaysia. Monthly data from 2016 to 2019 (48 data) were used to execute the Friedman test. The vehicle types were grouped into nine groups, as represented in Table 1.

Table 1. Friedman test rank

RTA fatality causes	Mean Rank
Motorcycles	9.00
Motorcars	8.00
Pedestrians	6.98
Lorry	5.51
4 WD	3.74
Others	3.80
Bicycles	4.32
Vans	2.25
Busses	1.40

Table 1 shows that the highest rank of fatal road traffic accidents was given to motorcycle accidents, while bus accidents were ranked the lowest fatal road traffic accidents. The second place went to motorcar accidents, followed by pedestrian, lorry, bicycle, other types of accident, four-wheel drive, van, and bus. This ranking indicated that motorcycle accidents contributed to the largest portion of fatal road traffic accidents in Malaysia for the past four years.

Fifty years' data of fatal RTA were collected from JKJR to be fitted into an ARIMA model to forecast the future number of RTA in Malaysia.

Table 2. Suggested ARIMA models

ARIMA Models	AIC	Log-Likelihood	σ^2 estimate
(2, 2, 2)	-174.74	92.37	0.001179
(0, 2, 0)	-156.93	79.47	0.002136
(1, 2, 0)	-155.87	79.93	0.002094
(0, 2, 1)	-163.45	83.73	0.001741
(1, 2, 2)	-176.08	92.04	0.001194
(0, 2 ,2)	-176.31	91.15	0.001247
(0, 2, 3)	-176.41	92.20	0.001186
(1, 2, 3)	-174.41	92.21	0.001186
(0, 2, 4)	-174.42	92.21	0.001186
(1, 2, 4)	-172.93	92.46	0.001171

Augmented Dickey-Fuller Test was also executed to test on stationarity. The p-value in the test is 0.9074, which means that the data is not stationary. The data was differenced twice (d=2) to make the data stationary. Next, different models were suggested by permutation and combination of different values of (p, q). With the order of differencing set fixed with d=2, 10 ARIMA models were suggested in Table 2 above. ARIMA (0,2,3) was picked as the best model to forecast RTA fatalities in Malaysia as it had the lowest AIC, large log-likelihood, and small error. The standardized residuals plots were then analyzed for any pattern or

trend; no prominent pattern or trend was identified, concluding that no significant correlation existed in the residuals. RTA fatality forecast was proceeded using ARIMA (0,2,3) and illustrated in Table 3.

Table 3. ARIMA (0,2,3) road traffic accident fatality forecast

Year	Point Forecast	Lower Boundary 80	Higher Boundary 80	Lower Boundary 95	Higher Boundary 95
2020	5934.763	5644.628	6224.898	5491.039	6378.487
2021	5957.269	5364.822	6549.717	5051.199	6863.339
2022	5911.229	5139.391	6683.066	4730.805	7091.652
2023	5865.188	4922.455	6807.921	4423.402	7306.974
2024	5819.147	4708.124	6930.171	4119.983	7518.311
2025	5773.106	4493.669	7052.544	3816.376	7729.837
2026	5727.066	4277.637	7176.495	3510.355	7943.776
2027	5681.025	4059.183	7302.867	3200.631	8161.419
2028	5634.984	3837.796	7432.172	2886.423	8383.546
2029	5588.944	3613.160	7564.727	2567.243	8610.644

Based on Table 3, RTA fatalities were noticed to decrease by 0.82% each year for the following ten years, with 5588 expected RTA fatalities in 2029.

4. Discussion

Different countries have different vehicles that are ranked as the highest fatal RTA. For example, in Korea, the largest percentage of fatalities was contributed by pedestrians. Meanwhile, in the United States of America, motorcar accidents had been the leading fatal RTA. The findings indicated that motorcycle accidents had contributed to the largest portion of fatal RTA in Malaysia for four years. In 1995, motorcyclists in Malaysia had contributed 59% to RTA death and serious injuries compared to the other groups of road users; meanwhile, the second highest of RTA fatality were pedestrians with 12%, and bicycle riders had the least number of road death of 5% (Kareem, 2003). These figures indicated a change in the rank of fatal RTA according to the type of vehicle, where the number of fatal motorcar accidents surpassed the number of fatal pedestrian accidents.

According to Rohayu et al. (2012), the best model for forecasting RTA fatality was ARIMA (0,1,1). Fatality frequency was forecasted to rise to 8,760 for 2015 and 10,716 for 2020. However, comparing the data from (Rohayu et al., 2012) and the data from this study, the former study obtained 10,716 for the road accident fatalities in 2020, and the result of this study obtained 5,974 numbers of road accident fatalities in 2020; in which former study forecasted an increase while this study suggested a decrease in RTA fatalities.

5. Conclusion

The highest rank of Malaysia fatal road traffic accidents went to a motorcycle accident followed by motor vehicle, pedestrian, lorry, bicycle, other, 4-wheel drive, van, and the lowest rank goes to a bus accident. Based on the forecast, the number of accidents will float around 5,900 cases yearly for ten years. Malaysia should confront human emotions and stress tests to drastically reduce the number of accidents.

Even though RTA fatality is projected to decline, preventive measures should be enhanced to ensure the forecasts turn into reality. Life insurers are advised to include the primary type of vehicles used in underwriting since premature death due to fatal RTA has been the top cause of death in Malaysia. The government, policymakers, and transport authorities pay more attention to preventive measures for RTA in order to minimize the burden and save more lives.

6. Limitations and Further Study

This study focuses on the road traffic injury incidence and fatality of RTAs in Malaysia, covering all types of road users, including pedestrians.

The method is recommended in this study; only figures can be analyzed. Meanwhile, some aspects can be interpreted better if done qualitatively. Since road users are human, psychological and physical behaviors, vary from each person, leading to different outcomes of road user behaviors.

For further study, it is recommended to incorporate human factors and physical vehicle conditions other than as determinants of RTA. Applying heterogeneous traffic data sources, which comprises geographic facts and statistics of traffic movements, would produce better outcomes.

Authors' Contributions

Azizi Yahaya (PhD) contributed to collecting, analyzing, and reviewing data.

Balan Rathakrishnan contributed to collecting, analyzing, writing the report, and revising data. Suraya Fadilah Ramli contributed to collecting data, presenting findings, analyzing and reviewing data, and report writing.

Ismail Maakip and Peter Voo are responsible for the overall study design and manuscript writing. Abu Bakar Madin conveyed the idea of the study and conducting research and revised the manuscript. All authors read and approved the final manuscript.

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