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Road Traffic Fatality Time Series Analysis in Dubai from 2012 To 2016

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ABSTRACT

Introduction: Road traffic crashes were second cause of death in the UAE. Many traffic regulations and fines had been implemented in UAE to control the high number of road traffic crashes.

Methods: This study is retrospective analytical study. We used data from road traffic crashes occurring in Dubai between 2012 and 2016. We extracted these data from Dubai Statistics Center (DSC) and Dubai Road and Transport Authority (RTA). We analysed the data using time series model by expert modeller of SPSS.

Results: The Road traffic fatality in Dubai had an increasing trend over the four years of study. Also, seasonality were overserved in time series. More road traffic deaths had been occurred during March, December, July (9.83%, 9.71%, and 9.10% respectively). The Winter's additive model was recognized as a best model in forecasting the trend of fatalities. Forecasting model also showed a ascending trend of traffic road fatalities over the next 4 years.

Conclusion: There was ascending trend in the study and the future 4 years. We need to investigate more about prevention measures for road traffic crashes. Also, further research is needed to study the correlation between temperature and fatal road crashes.

Keywords: Traffic accidents, Time series, United Arab Emirates, Mortality, Trend, Seasonality.

INTRODUCTION

According to the World Health Organization (WHO), road traffic injuries (RTIs) are the ninth leading cause of death globally, and the main cause of death among those aged 15–29 years.[1] More than 1.2 million people die each year on the world's roads.[1] WHO experts predicted that RTIs to become the seventh leading cause of death by 2030.[1]

Road traffic crashes happened due to the interaction between many risk factors. These factors were categorized by William Haddon into three: Human, Vehicles, and Environment (Haddon Matrix).[2] The Haddon matrix is an analytical tool to help in identifying all factors associated with a crash (pre-crash, crash and post-crash). It is important to identify and modify these factors through short-term and long-term interventions in order to prevent or reduce RTIs.[3]

Many researchers investigated the adverse weather conditions and as important risk factors in road traffic crashes.[4-9] However, Most RTCs studies in

the United Arab Emirates were concerned with injuries types and severity, human factors and vehicle factors involved in accidents.[10-17] Few researchers in UAE mentioned the importance of environmental factors in the causation of RTCs.[18-21] El-Sadig and colleagues mentioned that meteorological hazards such as fog and rain need to be documented in the police report on RTCs.[18] A study had been done on Al Ain hospital mentioned that there is a seasonal variation in RTIs admission (more in winter).[20] However, there is no single study discussed the seasonal variation of RTCs in the UAE or time series of road traffic mortality.

Road traffic crashes were second cause of death in the UAE despite the highly developed roads network and infrastructure.[22] The UAE's federal traffic law (No. 177 of 2017) came into effect on 1 July 2017 with more strict traffic control rules. Its aim to further protect the lives of road users and reduce traffic casualties from about 6 per 100,000 people to 3 per 100,000 as per Vision 2021.[23] We need to evaluate the effectiveness of this new government policy by studying previous road traffic crashes data and compare these data with new data after 1st July 2017. Wagenaar and colleagues reviewed the road traffic data from eight states in the USA using time series analysis after mandatory seat belt law. They found that a statistically significant decline of 8.7% in the rate of front-seat fatalities.[24]

We choose Dubai because it is located in the middle of the UAE with a rapid growth in population, economy, infrastructure and road network. Also, a huge number of people travelled daily from other cities to Dubai for work and business who could contribute in many road traffic crashes.

The aim of our study is to investigate the trend of road traffic mortality in Dubai city by using time series during 2012-2016 and forecast the road traffic mortality for the next 4 years. The study's result can be compared with future Dubai's road traffic data for the next 4 years.

MATERIALS AND METHODS

A retrospective-analytical study was done by review data sources. The primary sources of data were used for the study: (1) Dubai census from Dubai Statistics Centre (DSC) for RTCs numbers and death [25-29], (2) Dubai Road and Transport Authority (RTA) for registered vehicles in the Dubai and registered divers.[30-32] Table.1 shows a brief description of road traffic crashes in Dubai between 2012-2016. Monthly RTCs reports have been obtained from Dubai Statistic Centre over the period from the same period that consisted numbers of fatal road crashes per month (Table.2)

Ethics Statement: The entire data were collected from the DSC and RTA, in a de-identified manner. The Individual information like patient's name, personal details were not used in any part of the study.

Table.1 Yearly Road Traffic Fatalities during 2012-2016

Year	Reported Crashes	Fatal cases	Registered Vehicles	Fatalities per 100,000 registered vehicle	Fatalities per 100,000 population	Registered drivers	Fatalities per 100,000 registered driver
2012	2940	123	1137750	10.8	5.8	1798082	6.84
2013	2948	160	1264315	12.7	7.2	1753333	9.13
2014	2975	177	1413150	12.5	7.6	1886683	9.38
2015	3092	166	1482705	11.2	6.8	2041421	8.13
2016	3001	198	1570636	12.6	7.3	2168054	9.13

Table.2 Monthly Road Traffic Fatalities during 2012-2016

Month	2012	2013	2014	2015	2016	Total
January	7(0.85)	18 (2.18)	13 (1.58)	14 (1.7)	12 (1.46)	64 (7.7)
February	5 (0.61)	15 (1.82)	15 (1.82)	13 (1.58)	19 (2.31)	67 (8.13)
March	15 (1.82)	15 (1.82)	21 (2.55)	8 (0.97)	22 (2.67)	81(9.83)
April	10 (1.21)	12 (1.46)	20 (2.43)	18 (2.18)	12 (1.46)	72 (8.74)
May	2 (0.24)	7 (0.85)	19 (2.31)	10 (1.21)	28 (3.4)	66 (8.01)
June	11 (1.33)	15 (1.82)	5 (0.61)	14 (1.7)	19 (2.31)	64 (7.77)
July	14 (1.7)	17 (2.06)	13 (1.58)	13 (1.58)	18 (2.18)	75 (9.10)
August	12 (1.46)	13 (1.58)	9 (1.09)	20 (2.43)	9 (1.09)	63 (7.65)
September	7 (0.85)	14 (1.7)	16 (1.94)	12 (1.46)	9 (1.09)	58 (7.04)
October	12 (1.46)	8 (0.97)	15 (1.82)	11 (1.33)	17 (2.06)	63 (7.65)
November	13 (1.58)	13 (1.58)	13 (1.58)	20 (2.43)	12 (1.46)	71 (8.62)
December	15 (1.82)	13 (1.58)	18 (2.18)	13 (1.58)	21 (2.55)	80 (9.71)
Total	123 (14.93)	160 (19.42)	177 (21.48)	166 (20.15)	198 (24.03)	824 (100)

Statistical analysis: The study data were analysed using time series model. The time intervals were 60 months from January 2012 to December 2016. The prediction was made from January 2017 to December 2020. First of all, the data were entered into the Excel software. Then, all the information was double checked. Subsequently, data analysis was conducted using the SPSS version 24 software at the significance level of 0.05.

Expert modeller of SPSS software was used to fit the best suitable model for the time series data. The stationarity of the data was checked by autocorrelation function (ACF) and partial autocorrelation function(PACF). A seasonal adjusted factor (SAF) was used to determine the peak of seasonal variation. The Ljung-Box(modified Box-Pierce)test was used to determine if the model was correctly specified. Forecasting of the road traffic fatality was also done using the best fit model.

RESULTS

The number of registered vehicles increased from 1,137,750 in 2012 to 1,570,636 in 2016, a 27.6% increase. The highest rate of increase (11%) in the number of registered vehicles was observed between 2012 and 2013, and between 2013 and 2014, respectively. The number of registered driver increased from 1,798,082 in 2012 to 2,168,054 in 2016, a 20.6% increase. The highest rate of increase (8.2%) in the number of registered drivers was observed between 2014 and 2015. See Table.1

The absolute number of RTCs has been increasing over the study period; from 2940 in 2012 to 3001 in 2016 (Table.1). This translates into a 2% increase over this period. However, road traffic fatality increased from 123 in 2012 to 198 in 2016. Also, The number of road traffic fatalities per 100,000 population increased from 5.8/100,000 in 2012 to 7.3/100,000 in 2016 (Table.1). Moreover, road traffic fatalities per 100,000 registered vehicle increased from 10.8/100,000 in 2012 to 12.6/100,000 in 2016. There was raise in road traffic fatalities per 100,000 registered driver from 6.84/100,000 in 2012 to 9.13/100,000 in 2016.

The total number of fatal road cases in Dubai between January 2012 and December 2016 was 824. Average of reported fatal crashes was 13.73 per month (4.726 SD) and varying from 2 to 28 (median 13). Figure.1 show trend analysis of road traffic death which show an increasing trend of fatalities due to road traffic crashes according to months and year. Also, the data show a cyclic pattern which a sign for a seasonal pattern. The highest road traffic mortality per month happened in May 2016 with 28 death and lowest road traffic mortality per month happen in April 2012 with 2 death.

Also, Figure.2 shows a high percentage of road traffic death during March, December, July (9.83%, 9.71%, and 9.10% respectively).

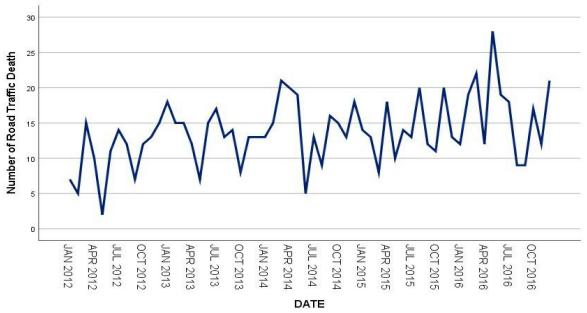

Figure 1: Sequence chart of total number of road traffic death (2012-2016)

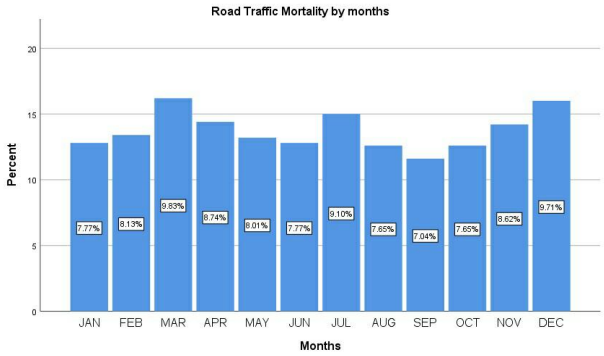

Figure 2: Monthly percentage of Road Traffic Mortality in Dubai (2012-2016)

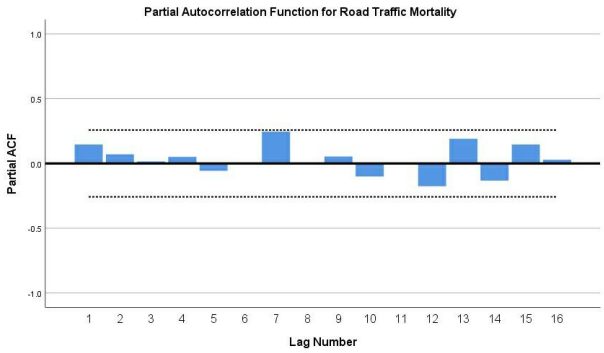

Figure 3: Autocorrelation Function Plots of Road Traffic Mortality in Dubai (2012-2016) After Removing the Non-stationary in Data)

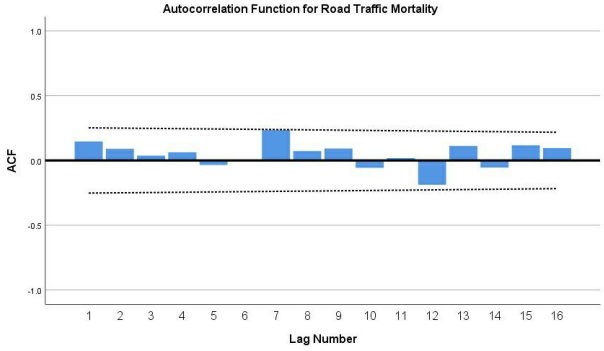

Figure 4: Partial Autocorrelation Function Plots of Road Traffic Mortality in Dubai (2012-2016)

Table 3: Model Statistics for Road Traffic Mortality

Model parameter	Road Traffic Death per month
Stationary R2	0.811
Ljung-Box statistic	
Statistic	18.637
DF	15
P-value	0.231
Model type	Winters' Additive

Table.4 Seasonal adjustment factor (SAF) for Road Traffic Death

Month	Observed cases	SAF (%)
January	64	94.4
February	67	106.9
March	81	118.7
April	72	104.6
May	66	98.0
June	64	101.5
July	75	107.6
August	63	98.1
September	90.1	90.1
October	82.7	82.7
November	98.3	98.3
December	99.0	99.0

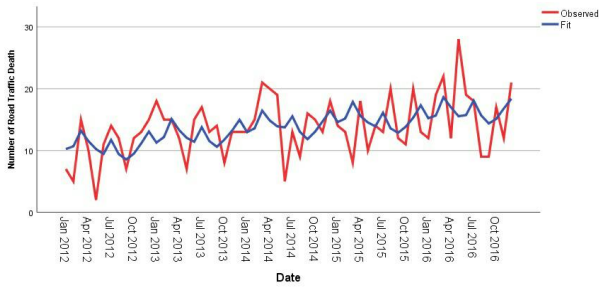

Figure 5: Actual (observed) and predicted (fit) values of road traffic death

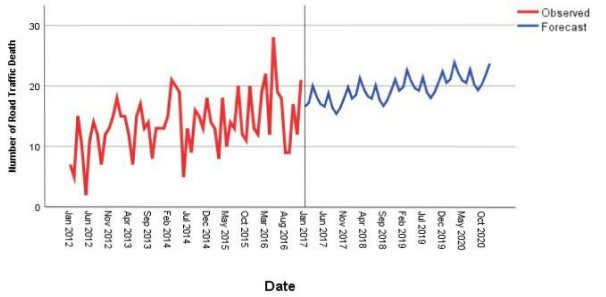

Figure.6 Forecasting Plot of Traffic Road Mortality

These data need more depth analysis by autocorrelation function (ACF). ACF showed that time series is stationarity (figure.3). Also, autocorrelation function show a peak at a lag of 7 (autocorrelation = 0.234; Box-Ljung statistics (P = 0.522)) suggesting the presence of a seasonal component. Moreover, the partial autocorrelation shows a peak at a lag of 7 which confirm the presence of a seasonal component in the data (Figure.4).

Expert modeller of SPSS suggested Winter's additive model as the best-fitted model for this time series data. Figure.5 shows that the observed actual values and the predicted model values matched reasonably well and there was consistency in the trend. Winter's additive model had been correctly specified by using Ljung-Box test results (Table 3). No outliers have been found in the data by an expert modeller.

A stationary R-squared value was used in this analysis which had been considered one of the fit measures for time series. This statistic measure provides an estimate of the proportion of the total variation in the series that is explained by the model and is preferable to ordinary R-squared when there is a trend or seasonal pattern, as is the case here. The high values of stationary R-squared (up to a maximum value of 1) indicate better fit. A value of 0.811 meant that the model could explain 81.1% of the observed variation in the series.

Winters' additive is method is preferred when the seasonal variations are roughly constant through the series. Time series values are treated as the sum of the components. It is exponential smoothing which most similar to an ARIMA with zero orders of auto-regression; one order of differencing; one order of seasonal differencing; and p+1 orders of moving average, where p is the number of periods in a seasonal interval. For monthly data, p=12.

February, March, April, June and July have seasonal adjustment factor (SAF) more than 100. March is a peak of road traffic death which coincides with the spring season in Dubai. In this month, the road traffic death is 19% above the typical months. Also, road traffic death more during the summer season (June and July). (Table.4)

The same model was used to forecast the monthly road traffic mortality incidence for the future from January 2017 to December 2020 that can be seen in Figure 6. The forecasted values also show an uprising trend over the years with a peak during the month of March.

DISCUSSION

The purpose of this study was to assess the trend of road Traffic mortalities between the 2012 and 2016 and forecast it for the next 4 years by using the time series analysis (SPSS Expert modeller). Our study findings showed an increasing trend over the past and future years. Also, results showed a higher of fatalities in 2016 (7.3 death per 100,000 population) when compared with 2012 (5.8 death per 100,000 population) (Table.1). Road traf-

fic mortality rate was uprising during the study period and highest score in 2014 (7.6 death per 100,000 population). This due to huge increase of Dubai population from 2,105,875 on 2012 to 2,698,600 on 2016 (28%).[25-29] Also, registered vehicles and registered drivers had been increased during the study period by 20.6%.[30-32]

Despite the speed cameras and traffic fines, the mortality rate was high during the study period. If we compared Dubai with New York state, road traffic fatality per 100,000 population had been decreased from 6.02 (2012) to 5.19 (2016) in New York state.[38] Enforcing the traffic fines and legislation in other countries had a positive effect in decline road traffic mortality. In the USA, a study showed that seat belt use in 2010 was 9% higher in the states with primary enforcement laws than in the states with secondary enforcement laws.[39] However, many studies had noticed a low seat belt wearing in UAE.[10,12,40] By studying the previous road fatality trend, we could measure the effectiveness of the new traffic law that comes into action by 1 July 2017.

We searched for RTA and Dubai police for Vehicle kilometres travelled (VKT), but we didn't find any open data. VKT give an accurate picture of the development of the road network and traffic legislation. In our situation, we consider only road fatality per 100,000 vehicles that are affected by driving habits, traffic legislation and the effectiveness of its enforcement, road design and other factors over which governments may exercise control.[33] Road fatality per 100,00 vehicles increased from 10.8/100,000 in 2012 to 12.6/100,000 in 2016 despite the developed and wide road all over Dubai. The increase in the number of vehicles does not necessarily lead to an increase in the rate of road traffic crashes.[34] In Sweden, the total traffic volume increased in 2014 by 2.3% compared to 2013.[34] In 2014, the road fatality in Sweden had reached 2.7 per 100,000 population when compared with 2013 (3 per 100,000 population).[34] Road fatality per registered drivers is an indicator for the role in driver education and licensing.[35] Our study found that the road fatality per 100,000 registered driver reach 9.13 by 2016. The lowest rate was in 2012 (6.84 per 100,00 registered driver). Fatality rate per licensed drivers in Dubai lower than US which was 16.90 fatalities per 100,000 licensed drivers in 2016.[36] Canada had 7.4 road fatality per 100,000 licensed drivers in 2016 that lower than Dubai data.[37]

More deep data analysis had been done by time series analysis for monthly road fatality in Dubai during the study period. As identified by Figure.1, seasonal and uprising trend during the study period. Also, there can be considerable fluctuations in monthly fatalities across each year. The possible explanation for the observed time variation pattern may be derived from the existence a link between road fatalities and weather during the year. As we noticed more fatal crashes during March, July and December in Dubai. Bener found that road traffic injuries in Al Ain were more during winter and spring.[20] However, Al Marzooqi and colleagues found that road traffic crashes in Dubai didn't follow a seasonal variation between 2002 to 2008.[13] Al-Dah found that road traffic injuries more during winter and spring and less during summer.[40]

Many studies had been done in many countries investigated the variation in road traffic crashes during adverse weather events.[5,6,8,9] However, the areas of interest in these studies were snow and rain. In UAE, usually the weather is clear but the hot environment and sandy winds were important factors in many road traffic crashes. El-Sadiga found that few road traffic fatalities were due to environmental factors between 1990 to 1998.[18] However, fog formation and sand storms had occurred more frequently in recent years.[41-43] Aldababseh and Temimi found that poor visibility events occur more frequently in Al Maktoum Airport and Dubai international airport during March, June and July.[42] They examined data from 1984 to 2016 for fog and dust events and they found significant upward increase for these events in Abu Dhabi and Dubai after 2000.[42]

Even, sand dust played an important role in the fast wearing of car engines in Arab countries.[44] Car companies need to change car engines in GCC countries to resist the fast wearing due to sand. Investigators in GCC countries need to investigate the correlation between sand dust and road traffic crashes due to engine failure. A study had been done on South Africa concluded that tyres and brakes were the most dominant components for mechanical defects causing road crashes.[45] Also, Shanks and colleagues found that 39% of road traffic accidents in Saudi Arabia were due to burst tyres.[46] Moreover, tyre failure road traffic crashes peaked between June and September in Saudi Arabia.[47] In our study, we found more road fatality in July during the study period that could be due to tyre failure.

This study has some limitations. Secondary data was used for this study so that the quality and integrity of the information depends on how it was originally recorded. Road fatality means any person killed immediately or dying within 30 days as a result of a road accident. We can't guarantee that Dubai police was using the same definition in their statistics. Also, no causality inference can be made from the findings. Moreover, Ramadan (fasting month) was in summer season during the study period. Data needs more investigation to found

any influence of fasting and fatal road crashes during Ramadan.

Nevertheless, this study has resulted in one of the first papers describing a monthly pattern for road traffic mortality in Dubai. The study results can be used as useful information for similar studies in road traffic crashes in UAE or even GCC countries. Also, the results may represent a useful tool for planning and be developing local interventions in Dubai.

CONCLUSION

Road traffic deaths are considered the second cause of death in UAE after cardiovascular events. A better understanding of road fatality trend during last 5 years could prevent it by implement preventive measures. The data suggested a remarkable increase in death from traffic accidents during March, July, and December respectively. Further research is needed on other outcomes of road traffic crashes such as the correlation between temperature and fatal road crashes and driver behaviour during hot climate.

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