Road Traffic Accident In Muscat: Trend Analysis And Forecast

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Abstract - **Growing population and developing in Sultanate of Oman along with high-speed highways interconnecting the cities and rapid increase in urbanization and motorization, the road accident rates have significant drawback. Oman experiences its own share of concentrated accident zones (blackspots) which are created due to a number of reasons. Some of which are excessive speeding, failure to abide traffic laws and regulations and other influencing factors. Road Traffic Accident (RTA) occur by a series of causations which can be attributed to the driver's fault, improper geometry, faulty vehicle, improper driving conditions, etc. The main objective of this research is to evaluate the road traffic accidents in Muscat by studying their trends, analyzing the RTA data and forecasting its future implications. Based on the conducted survey, it was seen that the majority of respondents had encountered at least one RTA within the past three years. About 50% of them admitted to driver over the speed limit, 44% admitted to speeding between speed detecting radars. The trend analysis revealed that majority of accidents from 2008-2018 were caused by three factors i.e. speeding, negligence and bad behavior. Due to the pandemic COVID-19 and its repercussions, the scope of this study was severely limited and an in-depth study with extensive RTA records is recommended for further research and model development.**

keywords - **Road traffic, accident, trend analysis, Accidents forecasting**

I. Introduction

About 1.5 million people lose their lives in a traffic-related accident each year. RTA has become one of the major causes of fatality especially amongst the bread-winner demography of society [1]. An estimated 300,000 people die every single year due to RTA [2]. It has become the 2nd and 3rd largest cause of deaths amongst 5-29 y/o and 30-45 y/o demography respectively [3]. More than 70% of the RTA victims are from the low to middle income countries which makes RTA an alarming concern of social and economic well-being of a country [1]. In Oman, according to the Ministry of Health (MoH) official reports RTA is the top cause for injuries, disabilities and it is number one cause of inpatient deaths [4]. Car driver behavior is utmost important in the events that led up to a RTA. A great deal of accidents occurs due to uneven geometry of the roads which may lead to development of concentrated zones of RTA known as blackspots.

Technological advancement and rapid urbanization increases the number of motorized vehicles produced which in-turn increases the chances of collisions evidently. Advancement in traffic regulations and management somehow always lags behind in contrast to the rapid development of the motor vehicle industry and as a result, the problem still persists on a large scale. Road accidents could be minor or major depending upon the impact and type of collisions either between the motorized vehicles or between a vehicle and road structure. The causes of these accidents are numerous, some of which are carelessness of the driver and disregards towards the traffic regulation, failure of proper regulators and signs, improper geometric construction of the roadway, etc. The causes of accidents, in Hyderabad-Karachi, included driver's fault, faulty vehicle, improper road conditions and pedestrians [5]. The results of the study showed a total number of 145 RTA in which 109 fatalities and 293 severe injuries were contained.

II. Risk Factors Influencing Road Traffic Accidents (RTA)

The factors that influence road traffic accidents in Hail (Saudi Arabia) include human factors, road conditions, defects in vehicles, excessive speeding and violation of regulations [6]. Another significant issue was the lower rates of obedience towards regulators and signboards and lack of abiding the seat-belt regulations. The research concluded that the traffic regulations must be strengthen and the laws governing the traffic regulation must strengthen their enforcement. This study could be more extensive in addressing the remedial methods to reduce the RTA's. In Poland, it had been observed that several thousands of people were killed annually and more than 10,000 people were injured. Failure to abide by the traffic law, low skills of driving, inability of driver to assess road situations, inadequate road infrastructure and poor conditioning of vehicles were the most common reasons of these crashes. Figure 1 shows the RTA trend based on the conducted survey [7]. It shows a decreasing trend but the fatalities are still very high by comparing it with injures.

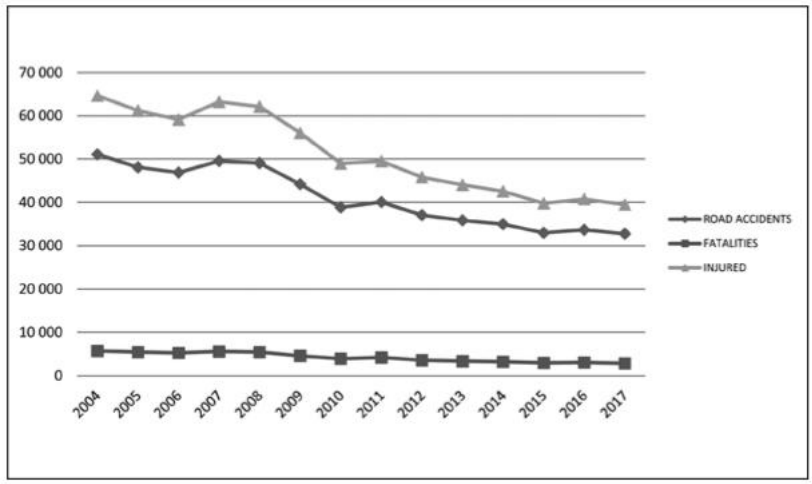

Figure 1 RTA, Fatalities, And Injuries Trend from 2004-2017 (Pawlowski Et Al. 2018)

In Ethiopia, within 12-month reference period, the injury rate of RTA was 163/100,000 [8]. Out of those 123 encounters, 28 were fatal which makes the rate of fatality 37/100,000 population sample. RTAs were ranked as the 2nd most common accident form and contributed to 43.8% of all fatalities. The study concluded that the RTAs are extremely high in Ethiopia and require urgent and serious attention in terms of country's public health.

III. Analyzing Road Traffic Accidents based on Literature

Mining technique method is used to analyze RTAs effectively [9]. The method had been implemented in 4 phases. These are: (1) preprocessing the raw data into and understandable format; (2) clustering data into groups based on similarity, (3) associating rules to define the underlying patterns of the data; and (4) classifying the data according to a model based on the previous steps. This research investigated the serious issues of RTA in Ethiopia using survey tools and secondary data.

Geographical Information System (GIS) is a very powerful tool that can be used for RTA data representation and analysis. GIS along with the recorded data were used based on the digital maps for province of Antalya, Turkey [10]. GIS shows that the major areas of RTA were on the intersections and boulevards, highroads and streets on the bases of parameters such as day, time, occurrence, type, character, number of casualties, etc.

RTA has a direct negative impact on social and national economy of any country. RTA incurs a 2% loss of GDP worldwide and it is one of the major causes of death in Maharashtra-India [11]. DYNAMO system was used to design a model which calculates RTA cost impact. Based on the research results, the human capital cost was 77% indicating a higher proportion and human suffering cost 22%.

IV. Strategies for RTA Improvements

The most common causes of RTA have been recorded and action plans were outlined in accordance to their findings in order to minimize the RTA rate [12]. Based on the literature results, the common causes were improper control and enforcement of traffic regulations, failure to abide the traffic law, insufficient infrastructure development and faulty vehicles. This research suggested that any improvement strategy must include measures such as reducing the exposure to risk of an accident, prevention, reduction in sustained bodily injuries and improvement of post-RTA medical care. It highlights the key problems and indicators of the previous literature and suggests important measures to be taken under account while trying to improve the condition of RTA rates.

A periodic statistical analysis had been performed by literatures on the number and severity of road accidents at critical locations (blackspots) to arrive at suitable and actionable measures in order to decrease them [13]. Malik [13] concluded that the major reasons for RTA on highways were due to high speeds on long straight stretches, at four legged junctions due to lack of traffic guidance and inadequate site distance, over taking resulting in head-on collisions, etc. The maximum casualties were recorded in cars followed by pedestrians/trucks. This research investigation was thoroughly implemented and practical/actionable measures were suggested alongside their justifications and predictable outcomes.

V. RTA Fatalities in Oman

Al-Maniri, Al-Reesi, Nasrullah, and Al-Zakwani [14] conducted a research study on the fatalities due to road accidents in the Sultanate of Oman through the year 1995-2009. the research had identified the demographic and trend of fatalities throughout this period. The study was carried out by collecting and analyzing the published reports by the Royal Oman Police (ROP) which included information such as the number of deaths age, nationality, sex, mode of travel and vehicle type and the data was analyzed using chi-square method for the % of fatalities and linear regression for the rate of the same. It shows that a total number of deaths related to RTA in this period was 9616 (48.5% of people were amongst the working-class age group, 82.4% of which were males and 75% of them were Omanis). The research was targeting individuals whom aged 26-50 Omani driving men. The primary recorded reason was the over-speeding. This is requiring a serious research towards understanding the risk behavior of young drivers in order to target interventions. As shown in Fig. 2, the rate of deaths in male is very high if it is compared with female deaths.

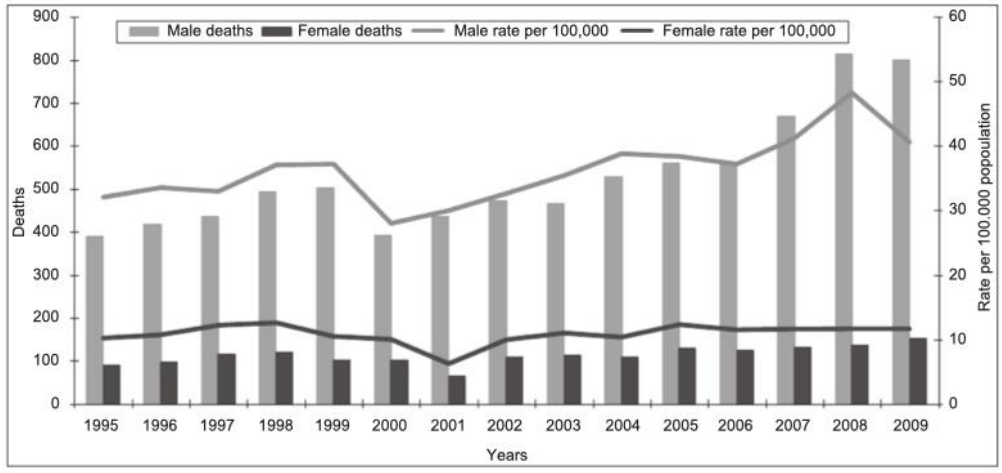

Figure 2 Death Rates in Oman [14]

Islam and Al Hadrami [4] proved that there a proportional relationship between the growth trend of motorization in recent years and road traffic accidents in Oman. The research showed that the rate of motorized vehicles in Oman exceed any other middle income country (230 veh. /1000 people) and has gone up by 26% during 2000-2009. The RTA are 70% due to collisions of which 70% involved are of age 17-36 years. The major causes of these RTAs were reported to be excessive speeding (50%), non-compliance with traffic regulations (29%) and other factors.

Al-Risi [15] performed an investigation on the characteristics of an RTA injuries and the risk factors involved in Oman. The main goal was to determine the distribution of RTA based on time, person, place. The studies showed that the rates of RTA have increased 300% since 1985 and speeding was reported as a major element in most of them causing fatality amongst young drivers (21-30 years) making up for 43.8% of total deaths from RTA. Amongst the injured drivers interviewed, 75% were male and 25% female and less than 5% of them were over 35 years of age. Traffic violations amongst males were higher (an average of 3 over 5 years) and half of that in females. 52.8% of the drivers interviewed reported almost never wearing seatbelts. The research concluded that the problem of RTA is high and on the rise in the Sultanate and demands appropriate legislative policies and increased enforcement against the violation of road safety policies.

VI. Research Methodology

The adopted method is mainly depending on collecting primary and secondary data. Qualitative and Quantitative mixed approach has been implemented by conducting online interviews and designing a questionnaire in order to collect the required data regarding Muscat-Sultanate of Oman. Having sufficient, organized and relevant data is the backbone of any research. Thus, a major challenge in conducting this research was the collection and organization of necessary data and analyzing it in an extensive method. This section provides a detailed discussion on the types of method implemented in order to obtain the data with respect to achieving the research objectives.

Questionnaire Survey

A Questionnaire is an instrument for performing quantitative data collection in a practical, time-efficient and systematic manner which produces scalable, comparable and actionable data [16]. It is an effective tool for gathering relevant information and personalized opinions of its respondents by the questions designed in it. The designed questionnaire survey is primarily focused on obtaining information on car driver behavior that is directly linked to RTA. The questions were designed to collect the related data without bias.

Selecting a right sample size is highly important in concluding a statistically significant and reliable result. Equation 1 [17] has been used for designing the sample size with a confidence level of 95% and a confidence interval of 8. The sample size of 150 respondents was selected.

$$ss = \frac{z^2 \times P \times (1-P)}{C^2} \qquad (1)$$

$$where: Z = constant; P = Percentage\ picking\ a\ choice; C = confidence\ level$$

The questionnaire was designed to be in three sections. The first section was designed to obtain some general data (gender, age, education level, driving experience, accident encounters, etc). The second section was prepared to assess the behavior and attitudes of car drivers in Muscat regarding issues such as over-speeding, accident awareness, awareness of degree of impact of a road accident as well as their general day-to-day habits which may be a threat to their safety. Third section was designed to collect recommendations on countermeasures against road traffic accidents along with the actions to be taken to overcome RTA issue.

Interview with Experts

Conducting a qualitative research such as interviews provides the researcher with an in-depth understanding of the research problem. It also embraces the opinion and viewpoint of the interviewee on complex issues that answer the more important questions [18]. Online (under COVID-19 pandemic) interviews with Senior Officers in the road accidents and safety department of Royal Oman Police have been conducted. The interviews questions were prepared to collect expert's opinion on the behavior and attitude of car drivers that may be linked to RTA in Muscat. Also, suggestions and recommendations against some of the main causes of RTA were obtained.

The advisable period for RTA data collection for any substantial study is more than 3 years. Being and lesser than 3 years would be misleading since it is insufficient information and could be labelled as random events [19]. Hence the data on RTA in Muscat was collected over a decade from the period of 2008-2018 to identify and examine the correlations and causations of these RTA. The main resources used for obtaining secondary data were online data portals such as the NCSI (National Centre for Statistics and Information) of Sultanate of Oman, road accident statistics from the website of the Royal Oman Police, journal articles and published papers by researchers in renown journals as well as supporting articles and data from the national news reporting websites such as Times of Oman and Oman Observer. The collected secondary data were number of accidents, type of accidents, number of injuries, and number of fatalities.

Data Analysis

Selection of appropriate analysis tools and procedures is crucial for obtaining substantial results and a solid conclusive end to the study. This section provides an in-depth knowledge on the various analytical tools and methods applied to analyze the collected data. Various approaches by researchers for analyzing car driver attitude using questionnaire based survey. Upon extensive research through the literature and based on the available data and accessibility to the software, a statistical analysis approach using SPSS software to analyze the questionnaire was adopted [20].

Frequency and descriptive statistics are good starting points for summarizing the multiple findings of a research into percentages, cumulative percentages, sums as well as the variation, standard deviation, standard errors, max. and min. of the data collected [21]. The frequency analysis produced the frequency, percentage and cumulative percentage from the total 150 responses given by the respondents for each of the question asked.

Factor analysis is primarily used for obtaining relationships and patterns between various quantitative data in order to form limited set of variable clusters for the ease of understanding and interpretation [22]. There are basically two major types, confirmatory and exploratory factor analysis. A rotated factor must include minimum 2 variables with a high correlation ($r > 0.70$) and the data set must be 10:1 ratio of respondents to variables to minimize errors [22]. A major limitation in this analysis is the accurate naming of the factors as it may not represent the variables in it accurately. Also, the measurement of Cronbach's alpha is popularly used in evaluating the internal consistency of the scales applied in a survey. Hence, in order to assess the reliability and internal consistency of the generated factors for the car driver behavior questionnaire, Cronbach's alpha reliability coefficients were calculated [20]. In addition, Pearson correlations or bivariate Pearson correlations measures the strength and interrelationship between pairs of variables [23]. After extracting factors and examining the reliabilities using the factor analysis and Cronbach's alpha, correlations between these factors were analyzed.

Analyzing a qualitative research such as an interview with an expert can be done in numerous ways. They are broadly classified as inductive and deductive analysis. Inductive Analysis is further sub-divided into thematic and narrative analysis. Deductive analysis requires a predetermined or structured approach in which the categories are predetermined and the collected data is linked to them [24]. A deductive analysis approach was adopted to specify the core issues in the car driver behavior which is common and highly linked to the RTA.

Road Accident Data

Al-Maniri, Al-Reesi, Nasrullah, and Al-Zakwani [14] performed a trend analysis and linear regression of RTA data in Oman from 1995-2009, extracting various information regarding the number, type and nature of accident as well as some demographic information on the people involved. Eboli and Mazzulla [25] analyzed the interdependence of various factors that cause RTA using Structural Equation Modelling. Based on the available data, analytical tools and resources, a combination of methodologies from previous literatures of analyzing the RTA data was adopted. Analysis of RTA data in this research was done in the two ways. These are graphical representation and structural equation model approaches.

The RTA data obtained over the course of a decade, 2008-2018 was analyzed using graph analytics in MS Excel in which the number of accidents, injuries and deaths occurring within the study period [14], various causes of RTA recorded within the study period, number of accidents, injuries, deaths, and trend analysis of the number of accidents [14] have been analyzed.

A structural equation model (SEM) is a technique of analyzing multivariate statistical data with a combination of factor analysis and multiple regression analysis [26]. There are various packages such as LISREL and AMOS [25] which allows the modelling of both the latent and the observed indicators describing a phenomenon. A SEM consists of a relationship between endogenous (dependent) and exogenous (independent) variables. It generally uses methods such as maximum likelihood (ML), weighted least square (WLS), which are described in detail by Bollen [27]. A simple structural equation model was built to analyze the structural relationship between the number of accidents and the top three factors causing those accidents i.e. speed, negligence and behavior recorded within the study period. The data for the modelling was sourced from the secondary resources such as NCSI [28] and ROP websites. The data (as shown in Table 1) was examined in the graph analysis and the top three causes of RTA, namely speed, negligence and driver behavior were selected as the exogenous variables and the number of accident was selected to be the endogenous variable.

Table 1 NCSI RTA Data 2008-2018 [28]

Year	No. of Accidents	Speed (accidents)	Negligence (accidents)	Behavior (accidents)
2008	7982.00	4734.00	919.00	1064.00
2009	7253.00	3744.00	615.00	1639.00
2010	7571.00	4032.00	494.00	1967.00
2011	7719.00	3861.00	569.00	1726.00
2012	8209.00	4328.00	721.00	1609.00
2013	7829.00	3952.00	845.00	1579.00
2014	6717.00	3510.00	606.00	1479.00

2015	6279.00	3411.00	655.00	1217.00
2016	4721.00	2499.00	672.00	705.00
2017	3845.00	2261.00	552.00	521.00
2018	2808.00	1634.00	370.00	379.00

A simple model was proposed due to the availability of data with number of accidents from Table 1 as the endogenous variable and the accident data for speed, negligence and behavior as exogenous variables. The general structure of the model is given below (Fig. 3) where the endogenous variable is linked to the exogenous variables which in-turn are interlinked. The e1 is an error variable computing for other factors affecting the endogenous variable which are not mentioned. IBM SPSS Amos is used as a platform to implement the suggested model for creating multivariate analysis including regression, correlation, factor and variance analysis [21].

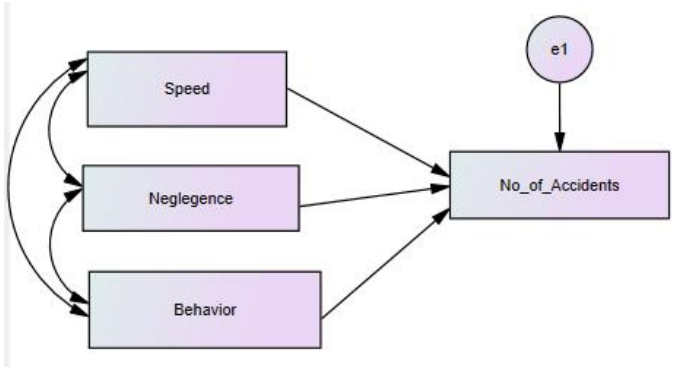

Figure 3 General Structure of RTA SEM.

I. Results and Discussion

In this section, all the analysis performed on the car driver behavior questionnaire is presented. It also contains the interpretation of all the findings presented. Table 2 shows the frequency distribution of the respondent's genders. Out of 150 respondents, 88 i.e. 59.33% were male and 62 i.e. 40.67% were female. This is useful for understanding the overall demography of car drivers in Muscat

Table 2 Gender Frequency Distribution

Variable	Value	Frequency	Percentage	Cumulative %
Gender	Male	88	58.7%	58.7%
	Female	62	41.3%	100%

As shown in Table 3, half of the total number of respondents i.e. 75/150 were millennials (within the ages 18 to 24 years). Following that were the age groups 25-30 years at 21.30%, 43+ years at 12.70%, 31-36 years at 8.7% and 37-42 years at 7.3%. This signifies that the majority of our respondents are the youth of the Sultanate which is preferable since they are the age group that most defines the country's growth [29].

Table 3 Age Frequency Distribution

Variable	Value	Frequency	Percentage	Cumulative %
Age	18-24 years	75	50.0%	50.0%
	25-30 years	32	21.3%	71.3%
	31-36 years	13	8.7%	80.0%
	37-42 years	11	7.3%	87.3%
	43+	19	12.7%	100.0%

Table 4 depicts frequency distribution of the respondent's educational level. It can be seen that the majority of them are graduate level i.e. 57.3% which is 86/150 respondents. The other end of the spectrum is for respondents who only qualify to read and write and it can be seen that just 1/150 i.e. 0.7% were in that category. In general, the respondents were fairly educated.

Table 4 Education Level Frequency Distribution

Variable	Value	Frequency	Percentage	Cumulative %
Education level	Reading & Writing	1	0.7%	0.7%
	High School	12	8.0%	8.7%
	Diploma	41	27.3%	36.0%
	Graduate	86	57.3%	93.3%
	Post-Graduate	10	6.7%	100.0%

Table 5 Driving Experience Frequency Distribution

Variable	Value	Frequency	Percentage	Cumulative %
Driving Experience	Less than 1 year	19	12.7%	12.7%
	1-4 years	68	45.3%	58.0%
	5-10 years	39	26.0%	84.0%
	11-15 years	15	10.0%	94.0%
	16+ years	9	6.0%	100.0%

Table 5 represents the frequency distribution of respondent's driving experience. As seen from the graph majority of car drivers have a fairly low experience of 1-4 years. About 26% of the car drivers had an average experience of 5-10 years and only 6% of the total respondents had an experience of over 16 years. This data confirms the majority age group of this research to be within 18-24 years of age.

Descriptive Statistics

The descriptive analysis helped in understanding the normality of the data by producing the minimum maximum, average responses, standard discrepancies from the averages, skewness, and kurtosis of the data which has a min and max bounds of -2 to 2 [30]. The Descriptive statistics were found out for the car driver behavior questionnaire (DBQ) to analyze its normality. The information in Table 6 shows that the data gathered from the DBQ was normal. The mean, min., max., S.D, skewness and kurtosis were all analyzed for the collected data. The values of skewness and kurtosis must be within the range of -2 to 2 which was satisfied by the set of data used as seen in the table below. The S.D value is closer to the mean which indicates that there is less variation in the set of data. Hence, this provides a good foundation for the validity of the findings.

Table 6 Descriptive Statistics

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Skewness**		**Kurtosis**	
	Statistic	***Statistic***	***Statistic***	***Statistic***	***Statistic***	***Statistic***	***Std. Error***	***Statistic***	***Std. Error***
gender	150	1.00	2.00	1.4067	.49286	.384	.198	-1.878	.394
age	150	1.00	5.00	2.1133	1.42149	1.034	.198	-.354	.394
Education	150	1.00	5.00	3.6133	.75784	-.720	.198	.596	.394
experience	150	1.00	5.00	2.5133	1.03455	.719	.198	.135	.394
distance	150	1.00	3.00	2.0400	.71306	-.058	.198	-1.014	.394
accidents	150	.00	7.00	1.3800	1.56587	1.304	.198	1.267	.394
Speed	150	1.00	5.00	2.5267	.91737	.185	.198	-.352	.394
Highway speeding	150	1.00	4.00	2.7533	.82687	-.161	.198	-.549	.394
Likelihood of accident	150	1.00	5.00	3.0400	.97540	-.125	.198	-.565	.394
Loss of control	150	1.00	5.00	2.8267	1.01497	.199	.198	-.800	.394
injuries	150	1.00	3.00	1.3933	.73180	1.522	.198	.626	.394
disabilities	150	1.00	3.00	1.7267	.88913	.568	.198	-1.502	.394
death	150	1.00	3.00	1.6867	.90588	.664	.198	-1.459	.394
Vehicle damage	150	1.00	3.00	1.3333	.70155	1.795	.198	1.490	.394
Road accident	150	1.00	5.00	3.7333	.84079	-.422	.198	.056	.394
Traffic violation	150	1.00	5.00	3.7267	.85841	-.537	.198	.392	.394
Improve control	150	1.00	5.00	3.7267	.88913	-.361	.198	-.261	.394
pleasure	150	1.00	5.00	2.8933	1.02418	-.011	.198	-.759	.394
Late for work	150	1.00	5.00	2.9133	.94788	.079	.198	-.669	.394
disrespected	150	1.00	5.00	2.2467	.98945	.371	.198	-.691	.394
Mobile phone	150	1.00	4.00	2.9933	.74633	-.578	.198	.408	.394
radio	150	1.00	4.00	2.7933	.80516	-.466	.198	-.062	.394
seatbelt	150	1.00	4.00	1.3467	.66541	1.827	.198	2.375	.394
indications	150	1.00	4.00	2.9533	.95071	-.618	.198	-.507	.394
sleepy	150	1.00	4.00	3.3333	.67224	-.647	.198	-.058	.394
medication	150	2.00	4.00	3.6667	.56363	-1.486	.198	1.262	.394
Car maintenance	150	1.00	4.00	3.3467	.67542	-.683	.198	-.049	.394
Reducing speed	150	1.00	5.00	3.4467	.96611	-.730	.198	.222	.394
night	150	1.00	5.00	3.5467	1.05923	-.588	.198	-.312	.394
rain	150	2.00	5.00	3.9800	.80660	-.897	.198	.822	.394
penalty	150	1.00	5.00	3.1467	1.25525	-.467	.198	-.801	.394
awareness	150	1.00	5.00	3.8200	1.06229	-1.029	.198	.876	.394
Valid N	150								

Frequencies

Car driver behavior is a major contributing factor to any road traffic accident [31]. It can also be indicated from the survey responses given by the respondents on their attitude towards speeding, traffic laws, negligence and awareness. The responses reveal that car driver attitude and perspective about speeding, negligence and bad behavior may be an indication to their road accident encounters. 64% of the respondents have experienced at least 1 RTA in last 3 years and about 10% experienced 4-5 RTAs as seen from Table 7 to Table 9 show that the majority of respondents admit to speeding. The accident and consequence awareness seems average from the responses recorded in Tables 9 to 14. Tables 15 to Table 26 shows that majority of the respondents tend to show negligence in safety and precautions such as using mobile, operating radio, nonuse of indicators, etc. Also, the majority of drivers agree that the awareness of driving safety and increase of penalties for repeated traffic law offenders could reduce the number of RTA in Oman. Overall, the level of awareness for road accident is examined to be moderate and could be improved and the attitude of the car driver is somewhat negligent and passive.

Table 7 Number of Accidents Encountered Within Last 3 Years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	56	37.3	37.3	37.3
	1.00	40	26.7	26.7	64.0
	2.00	26	17.3	17.3	81.3
	3.00	11	7.3	7.3	88.7
	4.00	7	4.7	4.7	93.3
	5.00	7	4.7	4.7	98.0
	6.00	2	1.3	1.3	99.3
	7.00	1	.7	.7	100.0
	Total	150	100.0	100.0	

Table 8 In Comparison to Other Drivers, Driving Speed Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Much faster	19	12.7	12.7	12.7
	Little faster	56	37.3	37.3	50.0
	Almost same	54	36.0	36.0	86.0
	Little slower	19	12.7	12.7	98.7
	Much slower	2	1.3	1.3	100.0
	Total	150	100.0	100.0	

Table 9 Exceed The Speed Limit On Highway In-Between the Speed Detecting Radars

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	All the time	9	6.0	6.0	6.0
	Most of the time	47	31.3	31.3	37.3
	Sometimes	66	44.0	44.0	81.3
	Never	28	18.7	18.7	100.0
	Total	150	100.0	100.0	

Table 10 When Exceeding the Speed Limit, Traffic Accident Likely Happened

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	8	5.3	5.3	5.3
	Disagree	37	24.7	24.7	30.0
	Neutral	53	35.3	35.3	65.3
	Agree	45	30.0	30.0	95.3
	Strongly agree	7	4.7	4.7	100.0
	Total	150	100.0	100.0	

Table 11 Loss of Control Over the Vehicle Due to Over-Speeding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	10	6.7	6.7	6.7
	Disagree	56	37.3	37.3	44.0
	Neutral	40	26.7	26.7	70.7
	Agree	38	25.3	25.3	96.0
	Strongly agree	6	4.0	4.0	100.0
	Total	150	100.0	100.0	

Table 12 Over-Speeding and Neglecting Traffic Laws Effects

		Frequency	Percent	Valid Percent	Cumulative Percent
Serious Injuries					
Valid	Yes	113	75.3	75.3	75.3
	No	15	10.0	10.0	85.3
	Maybe	22	14.7	14.7	100.0
	Total	150	100.0	100.0	
Permanent disabilities					
Valid	Yes	85	56.7	56.7	56.7
	No	21	14.0	14.0	70.7

	Maybe	44	29.3	29.3	100.0
	Total	150	100.0	100.0	
Passenger death					
Valid	Yes	92	61.3	61.3	61.3
	No	13	8.7	8.7	70.0
	Maybe	45	30.0	30.0	100.0
	Total	150	100.0	100.0	
Vehicle Damage					
Valid	Yes	120	80.0	80.0	80.0
	No	10	6.7	6.7	86.7
	Maybe	20	13.3	13.3	100.0
	Total	150	100.0	100.0	

Table 13 Abiding by The Speed Limit,

		Frequency	Percent	Valid Percent	Cumulative Percent
Decreases the likelihood of road accident					
Valid	Strongly disagree	1	.7	.7	.7
	Disagree	10	6.7	6.7	7.3
	Neutral	42	28.0	28.0	35.3
	Agree	72	48.0	48.0	83.3
	Strongly agree	25	16.7	16.7	100.0
	Total	150	100.0	100.0	
Decreases the likelihood of traffic violation					
Valid	Strongly disagree	2	1.3	1.3	1.3
	Disagree	9	6.0	6.0	7.3
	Neutral	42	28.0	28.0	35.3
	Agree	72	48.0	48.0	83.3
	Strongly agree	25	16.7	16.7	100.0
	Total	150	100.0	100.0	
Improves control over vehicle					
Valid	Strongly disagree	1	.7	.7	.7
	Disagree	12	8.0	8.0	8.7
	Neutral	43	28.7	28.7	37.3
	Agree	65	43.3	43.3	80.7
	Strongly agree	29	19.3	19.3	100.0
	Total	150	100.0	100.0	

Table 14 Commitment to Speed Limit and Traffic Laws

		Frequency	Percent	Valid Percent	Cumulative Percent
Reduces my driving pleasure					
Valid	Strongly disagree	12	8.0	8.0	8.0
	Disagree	45	30.0	30.0	38.0
	Neutral	46	30.7	30.7	68.7
	Agree	41	27.3	27.3	96.0
	Strongly agree	6	4.0	4.0	100.0
	Total	150	100.0	100.0	
Makes me late for work / college					
Valid	Strongly disagree	7	4.7	4.7	4.7
	Disagree	48	32.0	32.0	36.7
	Neutral	51	34.0	34.0	70.7
	Agree	39	26.0	26.0	96.7
	Strongly agree	5	3.3	3.3	100.0
	Total	150	100.0	100.0	
Makes me less respected amongst friends					
Valid	Strongly disagree	39	26.0	26.0	26.0
	Disagree	54	36.0	36.0	62.0
	Neutral	39	26.0	26.0	88.0
	Agree	17	11.3	11.3	99.3
	Strongly agree	1	.7	.7	100.0
	Total	150	100.0	100.0	

Table 15 Using Mobile Phone While Driving

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	6	4.0	4.0	4.0
	Most of the time	24	16.0	16.0	20.0

	Sometimes	85	56.7	56.7	76.7
	Never	35	23.3	23.3	100.0
	Total	150	100.0	100.0	

Table 16 Attention from The Road to Operate the Radio / Music

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	11	7.3	7.3	7.3
	Most of the time	34	22.7	22.7	30.0
	Sometimes	80	53.3	53.3	83.3
	Never	25	16.7	16.7	100.0
	Total	150	100.0	100.0	

Table 17 Fasten of Seatbelt While Driving

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	113	75.3	75.3	75.3
	Most of the time	23	15.3	15.3	90.7
	Sometimes	13	8.7	8.7	99.3
	Never	1	.7	.7	100.0
	Total	150	100.0	100.0	

Table 18 Switch Lanes Without Using Indications of My Vehicle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	15	10.0	10.0	10.0
	Most of the time	26	17.3	17.3	27.3
	Sometimes	60	40.0	40.0	67.3
	Never	49	32.7	32.7	100.0
	Total	150	100.0	100.0	

Table 19 Sleeping / Fatigue While Driving

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	1	.7	.7	.7
	Most of the time	14	9.3	9.3	10.0
	Sometimes	69	46.0	46.0	56.0
	Never	66	44.0	44.0	100.0
	Total	150	100.0	100.0	

Table 20 Influence of Medication or Intoxicants (Alcohol / Drug) While Driving

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most of the time	7	4.7	4.7	4.7
	Sometimes	36	24.0	24.0	28.7
	Never	107	71.3	71.3	100.0
	Total	150	100.0	100.0	

Table 21 Feeling Lazy to Do Regular Car Maintenance (Servicing, Brake Pad/Tyre Replacements).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	1	.7	.7	.7
	Most of the time	14	9.3	9.3	10.0
	Sometimes	67	44.7	44.7	54.7
	Never	68	45.3	45.3	100.0
	Total	150	100.0	100.0	

Table 22: Reducing The Speed On Highway Is Safer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	7	4.7	4.7	4.7
	Disagree	17	11.3	11.3	16.0
	Neutral	41	27.3	27.3	43.3
	Agree	72	48.0	48.0	91.3
	Strongly agree	13	8.7	8.7	100.0
	Total	150	100.0	100.0	

Table 23 Follow Traffic Laws at Night Times or On Vehicle-Free Roads

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	6	4.0	4.0	4.0
	Disagree	22	14.7	14.7	18.7
	Neutral	31	20.7	20.7	39.3
	Agree	66	44.0	44.0	83.3
	Strongly agree	25	16.7	16.7	100.0
	Total	150	100.0	100.0	

Table 24 Reducing My Driving Speed Below the Speed Limit of the Road During Rain

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	0	0	0	0

	Disagree	12	8.0	8.0	8.0
	Neutral	14	9.3	9.3	17.3
	Agree	89	59.3	59.3	76.7
	Strongly agree	35	23.3	23.3	100.0
	Total	150	100.0	100.0	

Table 25 The Government Must Increase the Penalty/Punishment for Breaking Traffic Laws

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	26	17.3	17.3	17.3
	Disagree	13	8.7	8.7	26.0
	Neutral	41	27.3	27.3	53.3
	Agree	53	35.3	35.3	88.7
	Strongly agree	17	11.3	11.3	100.0
	Total	150	100.0	100.0	

Table 26 Encouraging Good Driving Etiquettes/Mannerism Via Elaborate Awareness Campaigns

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	9	6.0	6.0	6.0
	Disagree	5	3.3	3.3	9.3
	Neutral	31	20.7	20.7	30.0
	Agree	64	42.7	42.7	72.7
	Strongly agree	41	27.3	27.3	100.0
	Total	150	100.0	100.0	

Factor Analysis

The factor analysis for the car driver behavior questionnaire helped in understanding the factor loadings and the main questions of the research. For example, in Table 28, it can be seen that questions 15, 16, 17 & 32 loaded within a component with .852, .817, .751 & .776 values respectively. This showed that the relationship between them are high (75-85%) and they can be transformed into an equivalent variable named Accident awareness as seen below. Similarly, other questions which loaded together and showed a good relationship (>0.5) were transformed.

The factors extracted from the factor analysis (Table 27) using the verimax rotation component analysis were,

- Accident awareness: comprising of Q.15 + Q.16+ Q.17 + Q.32
- Speeding awareness: comprising of Q.7 + Q.8 + Q.9 + Q.10
- Attitude: comprising of Q.18 + Q.19 + Q.20
- Negligence: comprising of Q.21 + Q.22 + Q.24 + Q.25 + Q.26

Table 27 Rotated Component Matrix

	Components				
	1	*2*	*3*	*4*	*5*
Q.7 Speed		.353		.577	.547
Q.8 Highway speeding			-301	.476	.517
Q.9 Likelihood of accident					.659
Q.10 Loss of control					.825
Q.11 injuries			.746		
Q.12 disabilities			.781		
Q.13 death			.744		
Q.14 Vehicle damage			.592		
Q.15 Road accident	.852				
Q.16 Traffic violation	.817				
Q.17 Loss of control	.751				
Q.18 pleasure				-.799	
Q.19 Late for work				-.783	
Q.20 disrespected				-.359	
Q.21 Mobile phone		.843			
Q.22 radio		.828			
Q.23 seatbelt					
Q.24 indications		.634			.363
Q.25 sleepy		.648			
Q.26 medication	.337	.574			
Q.27 Car maintenance		.362			
Q.28 Reducing speed					
Q.29 night					
Q.30 rain					
Q.31 penalty					
Q.32 awareness	.776			.552	

Extraction Method: Principle Component Analysis, Rotation Method: Verimax with Kaiser Normalization
a. Rotation converged in 1.8 iteration

Reliability Analysis

The reliability analysis for the car driver behavior questionnaire data in this research was done with the help of SPSS package using its Cronbach alpha reliability analysis. A value higher than 0.7 is sufficient in indicating internal consistency of the research data [32]. The analysis was performed for the entire questionnaire as well as the variables generated from the factor analysis.

Table 28 Reliability Analysis of Entire Questionnaire.

Cronbach's Alpha	N of Items
.691	32

Table 28 shows the reliability analysis of entire questionnaire which is .691 or 69% for 32 items which can be considered acceptable or just below acceptable according to many social sciences sources. Table 29 shows the reliability analysis of the variables generated in the factor analysis. All 4 factors i.e. Accident awareness, speeding awareness, attitude and negligence have shown to have internal consistency and the data sets collected for them are reliable.

Table 29 Reliability Analysis of Factor Analysis Variables

	Cronbach's Alpha	N of Items
Accident awareness	.727	4
Speeding awareness	.685	4
Attitude	.848	3
Negligence	.755	5

Correlations Analysis

Correlation analysis indicates the relationship between each other and its significance [33]. It is critical in understanding the correlations of the variables computed from the factor analysis of the car driver behavior questionnaire. There were 4 factors generated and transformed in SPSS. These variables were analyzed for their correlations and Table 30 indicates the results of it. It can be seen that the correlations of these factors are very significant (**. = 99%) and this indicated a strong correlation between them and the values indicate the percentage of variance explained in each variable by the corresponding three variables. For example, the accident awareness showed a significant correlation with speeding awareness, attitude and negligence with +34%, -33.8% and -33.2% of its variance explained by the three corresponding variables respectively. The '+' sign indicates a positive correlation and '-' sign indicates a negative correlation i.e. as the accident awareness increases, the speeding awareness also increases and the precarious attitude and negligence of the driver reduces.

Table 30 Correlations Between Factor Analysis Variables

		Accident awareness	Speeding awareness	Attitude	Negligence
Accident awareness	Pearson Correlation	1	.341**	-.338**	-.332**
	Sig. (2-tailed)		.000	.000	.000
	N	150	150	150	150
Speeding awareness	Pearson Correlation	.341**	1	-.394**	.350**
	Sig. (2-tailed)	.000		.000	.000
	N	150	150	150	150
Attitude	Pearson Correlation	-.338**	-.394**	1	-.230**
	Sig. (2-tailed)	.000	.000		.005
	N	150	150	150	150
Negligence	Pearson Correlation	-.332**	.350**	-.230**	1
	Sig. (2-tailed)	.000	.000	.005	
	N	150	150	150	150

**. Correlation is significant at the 0.01 level (2-tailed).

Interview Results

Based on the conducted interview conducted with the R.O.P as well as secondary aid for better interpretation. The major causes have been commonly observed with road accidents are negligence and excessive speeding. Islam and Hadrami [4] investigated that 50.94% of all the total RTA were caused due to excessive speeding and 29.28% of the total RTAs were caused by negligence i.e. improper attention, distractions, use of mobile/radio, etc. Moreover, the National Center for Statistics & Information shows that out of 2802 RTA recorded in Oman in the year 2018, 1634 were caused due to over speeding [28]. Also, the experts have confirmed that the most common behaviors that cause road accidents are lack of attention, not adhering to safety measures such as wearing seatbelt, and using mobile phone. Sabbour and Ibrahim [34] confirmed that the most common driver behaviors that caused accidents were answering phone calls, safety law violations, exceeding limited speed, avoiding seat belts, etc.

On the other hand, the most crucial measures taken by the traffic and road safety department of ROP are introducing frequent checkpoints, penalizing the offenders of traffic laws, and regulating traffic jams. These countermeasures have seen a significant decline of traffic offenses and road accidents in the Sultanate of Oman. According to NCSI [28] reports, although the accident and death rates are still an issue, the total number of RTA have been on a steady decline from 2012 to 2018 [28] .

In addition, experts have recommended that the driver can avoid road accident by always wear a seatbelt, postpone any calls while driving, wear appropriate eye glasses for proper vision, and comply with the traffic law and speed limitations. Additional points of suggestions and recommendations are provided from literature such as increasing enforcement, increasing awareness and education, and suspension of license for repeated offenders [35].

Road Accident: Trend, Causes and SEM

This section contains all the analysis performed on the secondary set of data collected from the government records. As shown in Fig. 4, the graphical representation of the road traffic accident data shows the general trends of accident, injuries and death over the past decade (2008-2018). It also shows the various causes of accidents over the decade and a basic trend analysis to predict the road accidents for the next decade (2020-2030).

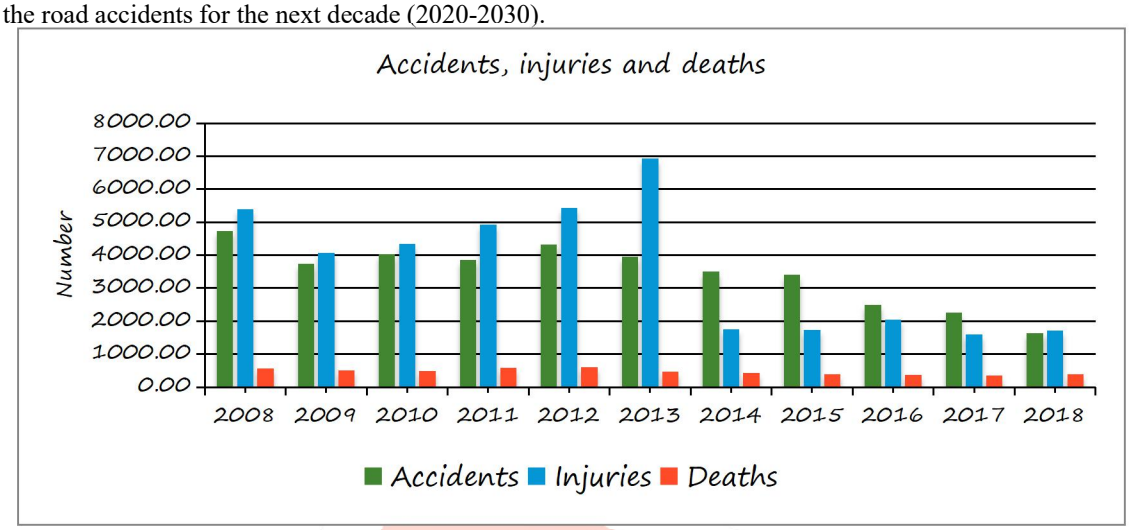

Figure 4 Accident, Injuries and Deaths Between 2008-2018.

Figure 4 depicts the general trends of the overall number of accidents, injuries and deaths recorded by NCSI [28] over the last decade from 2008-2018. As shown, the total number of accident have been relatively similar until 2012 after which there has been a steady decline in the overall road accidents. The number of injuries took a sudden dip from 2013-2014 from 6923 injuries to 1743 injuries which can be attributed to the traffic law and penalty amendments made by the ROP in 2014. The death rates have been on a gradual and minimal decline over the years. This graph represents the progress of Oman's traffic and safety regulators in reducing the accidents in the country.

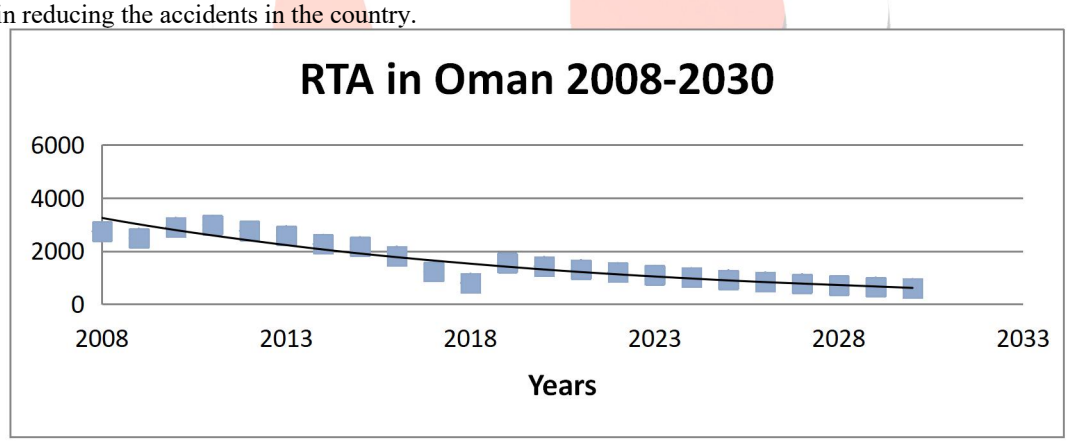

Figure 5 Trend Analysis of RTA in Oman (2008-2018)

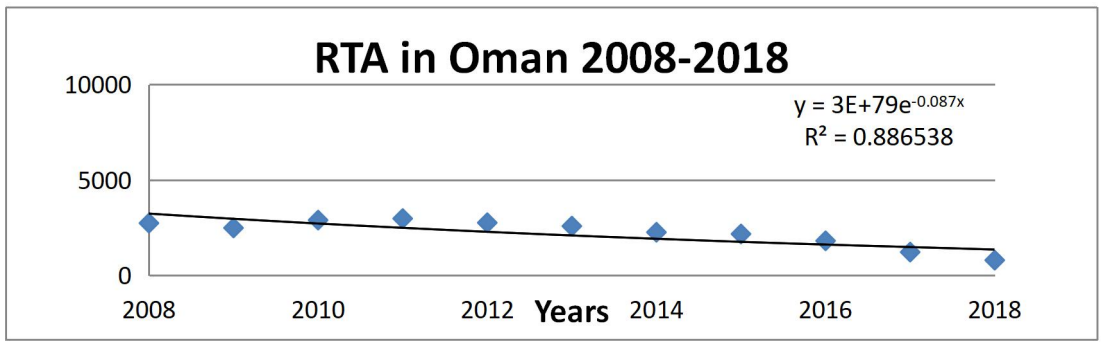

Figure 6 Trend Analysis of RTA in Oman (2018-2030)

Figures 5 and 6 depicts the trend analysis performed on the total number of accident statistical data for the decade 2008-2018 and 2008-2030 respectively. The trend analysis was performed by performing a scatter plot and adding an exponential trend line to get a general direction of RTA in Oman. As it can be seen from Fig. 6, the trend of RTA has been on a decline over the past decade and the R-squared value (R2=0.886538 i.e. 88.6%) indicates a good reliability of the trend line [36]. The

trend line also gave an equation for the general trend of the accidents which was y = 3E+79e-0.087x, where y is the accident trend line, x is the year and e is mathematical constant. Using this equation, the forecasted trend was formed in Fig. 7 which shows that the decline will further propagate gradually given that the conditions for traffic safety and regulations are ideal.

The major causes are also explored more for the total number of accidents, injuries and deaths caused by them. Figure 7 represents the number of accidents caused by various factors recorded over the decade 2008-2018. It can be seen that throughout the entire decade, speed has been the largest cause of RTA in Oman. Following that, bad behavior and negligence of the driver are the 2nd and 3rd largest causes respectively. Other factors such as intoxication, not maintaining safe distance, vehicle defects, flaws on the road, overtaking, weather, etc. have also contributed to the RTA in Oman over the past decade. The number of accidents caused by all of these factors seem to be declining over the years, this could be attributed to the 2011-2020 global road safety target actions. Although the accidents rate is cut in half, they are still significant to pose a hindrance to the Sultanate's economic and social growth.

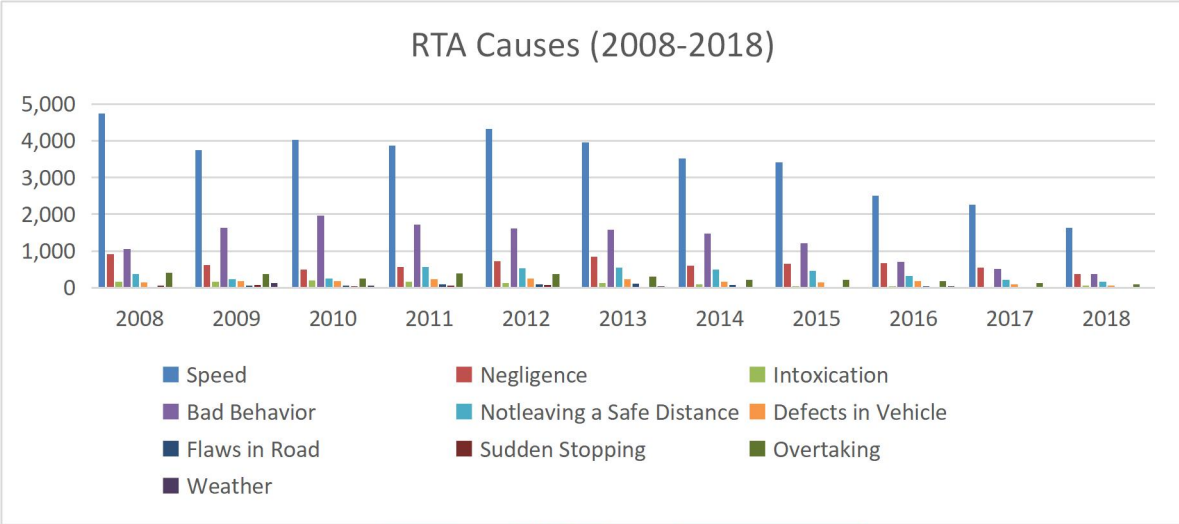

Figure 7 Causes of RTA in 2008-2018

As discussed the majority of road accidents occurring in Oman in the year 2008-2018 were caused due to speed, negligence and bad behavior. These three factors make up for more than 75% of the total RTAs. the following section contains statistics on the accidents, injuries and deaths caused by each of the three factors. This data is then computed into a Structural Equation Model (SEM) using IBM SPSS AMOS software to analyze a linear regression model. Figure 8 depicts the statistics of injuries, deaths and accidents occurring in Oman due to speed over the decade of 2008-2018. The graph shows that the number of deaths occurring due to over-speeding has been somewhat constant while the accident and injury rates have been on a gradual decline after 2012.

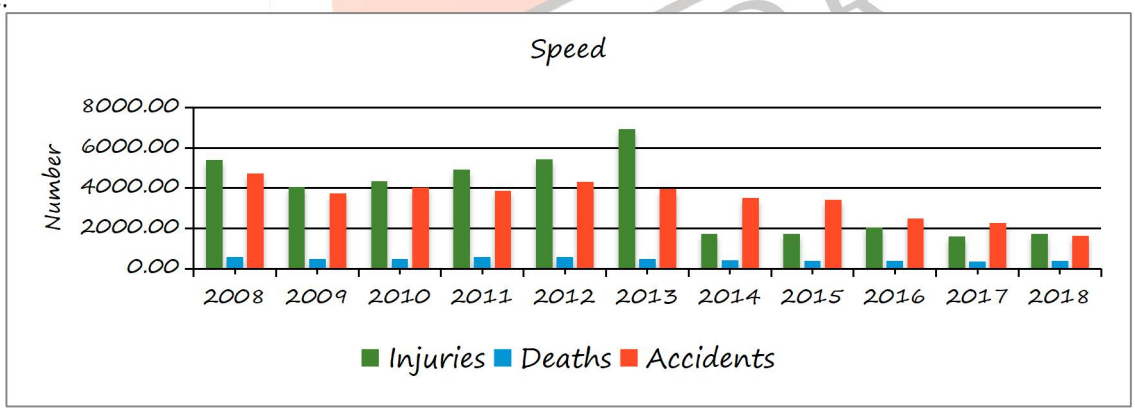

Figure 8 Deaths, Injuries and Accidents Caused by Speed.

Figure 9 shows the statistics of injuries, deaths and accidents occurring in Oman due to bad behavior over the decade of 2008-2018. Similar to the statistics seen in Fig. 9, the rate of accident and injuries have been on a decline since 2012 however the rate of accident has been relatively same.

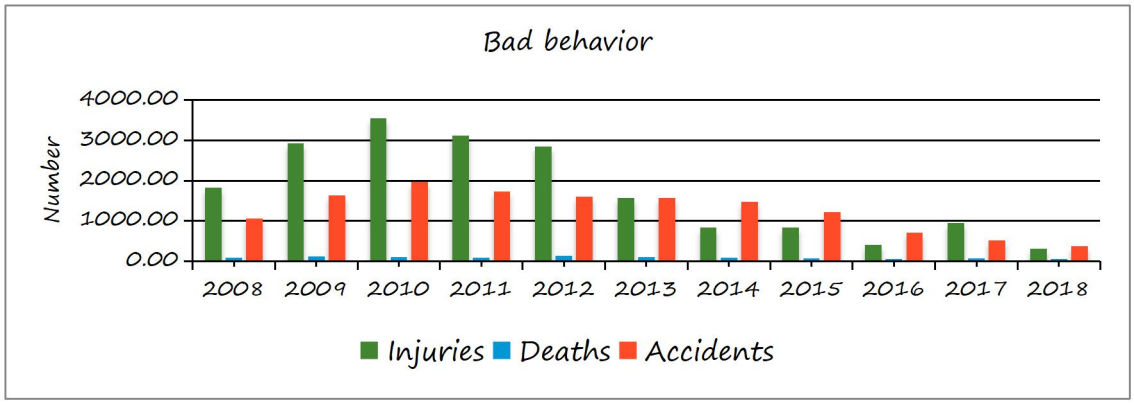

Figure 9 Deaths, Injuries and Accidents Caused by Bad Behavior.

Figure 10 shows the statistics of injuries, deaths and accidents occurring in Oman due to bad behavior over the decade of 2008-2018. The rate of accident and injuries have been sinusoidal throughout the decade without any proper progression. However, a steady decline can be noticed in the number of accidents from the year 2016-2018.

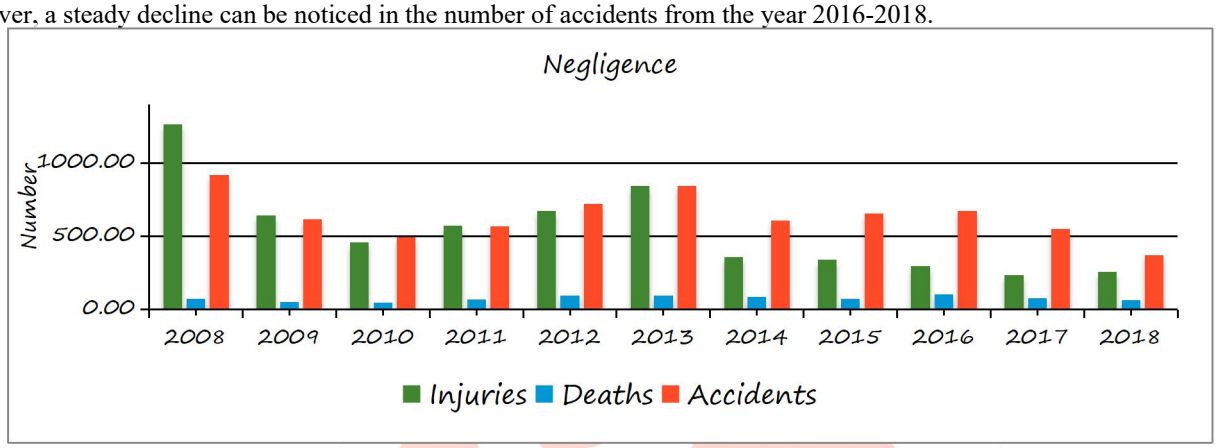

Figure 10 Deaths, Injuries and Accidents Caused by Negligence

The statistics of accidents numbers mainly caused due to speed, bad behavior and negligence as well as the total number of accidents from Fig.11 are together computed in the AMOS software to analyze their relationship and develop an SEM.

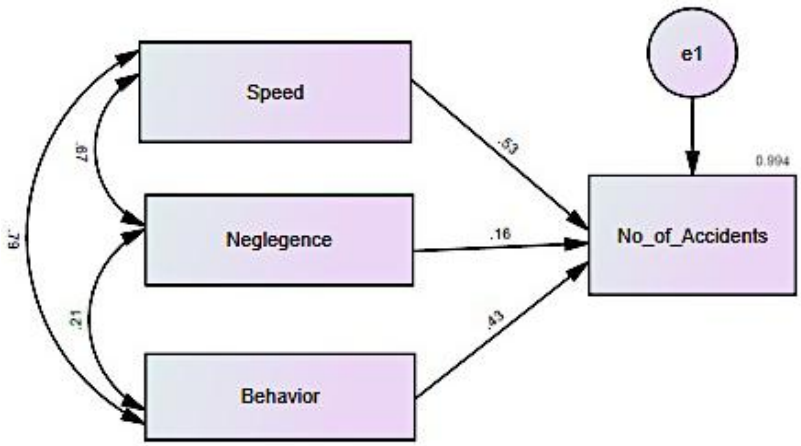

Figure 11 Structural Equation Modelling

Figure 11 shows the SEM with exogenous variables as speed, negligence and behavior and endogenous variable as number of accidents. The R-squared value of the model is 0.994 i.e. 99.4% which is highly significant and that the variables determine 99.4% of variance in the number of accident. The standardized beta coefficients of this linear regression are .53, .16 and .43 for speed, negligence and behavior respectively. The P values as seen in the Table 32 below shows a *** which indicates higher significance (P = 0.00 i.e. <0.05). Also, the critical ratio (C.R) which is a ratio of Estimate/Standard Error (S.E) is greater than 1.69 for each of the three relations which is another indicator of its significance [37].

Table 31 Linear Regression Weights from Amos.

	Estimate	S.E.	C.R.	P Label
No_of_Accidents <--- Speed	1.032	.148	6.974	***
No_of_Accidents <--- Negligence	1.971	.567	3.477	***
No_of_Accidents <--- Behavior	1.494	.200	7.481	***

II. CONCLUSION AND LIMITATIONS

The main aim of this research was to study and analyze the trend of road traffic accident in Oman and to evaluate the car driver attitude that may be a direct/indirect cause of these accidents. For this purpose, a mixed research methodology was adopted by conducting questionnaire research on the car driver behavior, interview with an R.O.P officer and study on the secondary RTA statistics found through government records. Upon collecting various forms of data and running different analysis on them, the following conclusions were drawn.

The driver behavior questionnaire as the name suggests, was used to assess the car driver behaviors that may be linked to RTA and it was seen that the majority of respondents i.e. 64% had encountered at least 1 RTA within the past three years. About 50% of them admitted to driver over the speed limit, 44% admitted to speeding between speed detecting radars. Furthermore, their comprehension of consequences due to speeding seemed somewhat casual. In terms of driving etiquette, 76.7% admitted to using mobile phone, 83.3 admitted to distracting themselves with radio operations, 67.3% admitted to switching lanes without indication. Overall, the car drivers surveyed for this report indicated behaviors such as speeding and negligence whilst showing somewhat casual attitude towards RTA awareness. By further performing SPSS analysis on these major factors, it was also confirmed from the factor, reliability and correlation analysis that the lack of accident awareness is in indirect proportion to the car driver's attitude, speed awareness and negligence and their correlation is highly significant.

The interview with R.O.P officer further helped in identifying the common causes of RTA in Muscat. He too confirmed with the major causes reported as being of negligence and excessive speeding. He also informed of the common mistakes of car drivers such as attention diversion, use of mobile, not using seatbelt causing these RTA. Further, he gave recommendations such as introducing frequent checkpoints, raising penalties and regulating traffic jams for reducing these RTAs as well as suggested that drivers must adhere to seatbelt and other safety rules, postpone calls, wear appropriate eyewear and comply with law and regulations for their own safety.

Studying the secondary statistics on RTA in Oman for 2008-2018 revealed that the overall RTA rates have been on a steady decline since 2012 due to the new safety regulations introduced in the same year. By plotting trend line for the same, a forecast of further reduction in RTA over the next decade (2020-2030) shows a further gradual decline of these accidents to a significantly low rate, given the advancement in laws and regulations keep up with the latest technological and motorized advancements.

A Structural Equation Model was developed by observing the major causes recorded for RTA in 2008-2018, i.e. speeding, negligence and bad behavior and relating it with the total number of accidents reported in the same duration. The model revealed that these factors did in fact explain about 99.4% of variation in the number of accidents over the years and within these variables, there existed correlations of certain significance.

In conclusion, the car driver behavior such as bad behavior, negligence, speeding, mobile phone does in fact pose a significant threat to causing a road accident. The car drivers are highly suggested to adhere to safety regulations such as following seatbelt law, not crossing the speeding limitations, postponing phone calls and wearing appropriate vision eyewear to be aware of any hazard while driving. The trends of RTA in Muscat are on a steady decline and are forecasted to be further declined to around 600 in the year 2030 provided the road safety and laws keep up with the technological advancements in the motor industry.

Research Limitation

Due to the pandemic COVID-19 and its repercussions, the scope of this study was severely limited to the usage of secondary sources of data only. Attempts of conducting primary research methodologies such as the driver behavior questionnaire and interview with experts were limited only through remote means. Collection of necessary data for a full in-depth research on the specific cause and effect of RTA was also limited only to online records.

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