Journal of Engg. Research Vol.10 No. (1B) pp. 86-102 DOI: 10.36909/jer.10565

Car following behaviours on multilane highways in Kuwait: A case study on road 40 during winter season

Eisa Alenzi*, Sitti Asmah Hassan and Othman Che Puan*****

, School of Civil Engineering, Faculty of Engineering, 81310 UTM Johor Bahru, Johor, Malaysia*
**** Department of Civil Engineering, Engineering College, Universiti Malaysia Pahang, Malaysia*
** Corresponding Author: alhajab@hotmail.com*

Submitted ***:*** 27/05/2020
Revised ***:*** 30/03/2021
Accepted ***:*** 11/04/2021

ABSTRACT

The car following behaviour of a driver is the process of following the drivers' creation of an adjustment in the leading vehicle behaviour. In a condition, where the traffic volume is in a free-flowing situation, the selection of vehicles speed is typically limited by some factors such as weather conditions, lighting, and road geometry features. This study aims to investigate the effects of climates on driver's car following behaviour and speed flow relationships for highways in Kuwait. The case study was conducted at Road 40 in Kuwait using RTMS Sx-300 device, which is known as a radar device particularly used for monitoring traffic. The data was gathered in the period from 29th December 2018 to 5th January 2019 in winter. MATLAB code was written to analyse and classify the gathered data. Then, the models were built using R-software. The study depicts that nearly 24.87% of the vehicles move between 60 km/h and 69 km/hour. Additionally, the vehicles were segmented according to their types, i.e., Truck, Small-, Medium-, and Large-Sized Cars, in order to find the impact of following pattern on the vehicle average. It has been found that no significant association remains amidst the type of following pattern and the headway. Ultimately, a liner regression of data was developed to calculate a liner equation that shows the average headway as an element of speed for sixteen diverse following patterns. It has been recognized that an association could be supposed in medium-sized and small-sized vehicles. It has been observed that headway average could be placed in a linear equation for large, medium, and small as well as truck vehicles. It is worthy denoting that when data is bigger, the exactitude of a study is enhanced. Findings from each model of liner regression have more than 80% confidence level. The models of regression are deliberated as statistically significant, where the R (square) figures lie amidst 0.99 till 0.6. As per the findings, speed is the key influencing factor for headway value. The type of car does affect headway with drivers behind Heavy Good Vehicles and cars at the similar speed. According to the data, cars are identified to keep more headway when behind Heavy Good Vehicles in contrast with when behind other cars. These results will help the drivers understand their behaviour associated with car crashes, thus, increasing road safety awareness and reducing traffic congestion in Kuwait.

Keywords: Car following; Driver behaviour; Headway; Multilane highway.

1. INTRODUCTION

Road safety and road traffic handling capacity are the two main aspects of traffic planners and engineers that are taken into consideration. Both of the analyses are linked with road users' behaviour either indirectly or directly. Issues related to road traffic analyses are based on cars of nondynamic driver in most of the cases following behavioural concept. For example, often the driver's car is considered as unrelated at the speed of vehicle at which it usually travels. On the other side, the analysis of road capacity on the American Highway Capacity Manual is framed on the basis of American traffic environment (Zhao et al., 2018). Such type of methodologies leads to an inappropriate problem assessment and, in the end result, in inaccurate planning of developments. Therefore, it is essential to take into consideration the localized traffic behaviours in the analysis of capacity and road safety.

The car of a driver following behaviour is the procedure of following the attempt of drivers to create adjustment in the leading vehicle behaviour. In a condition, where the traffic volume is light or in a free-flowing situation, vehicle speed is typically limited by some factors such as weather conditions, lighting, and road geometry features. The required speed is limited by desired speed of a driver and vehicle performance when negotiating alignment of different road directions. Specifically, the needs of a driver to adjust position and speed must be considered to keep a safer following distance every time (such as avoiding rear-end collision with the vehicle behind). This is known as a driver's vehicle following headway or distance. Besides, this occurrence could be perceived when a faster car catches up and is unable to overtake immediately a slower vehicle in huge traffic jam situation. Typically, by definition, the impeded car has a desired speed, which is considered as higher in comparison of the leader (Liu et al., 2018).

The multilane highway can be defined as a highway consisting of 4 to 6 lanes considering both directions. Usually, multilane highways are constructed along rural and high-volume suburban corridors, which link two cities for essential activities and help generate substantial amount of everyday trips. Such type of trips follows behaviour and generates trips, which are different because of various factors. Consequently, the car of a driver following behaviour was modelled and studied by several investigators, mostly focusing on highways consisting of two lanes over the past few decades (Liu et al., 2018; Puan et al., 2020; Ling 2006; Taieb & Shinar, 2001). Liu et al. (2018) developed a revised car-following model utilizing an intelligent driver model (IDM) in order to extract drivers' perceptions of their preceding traffic conditions by vehicle-to-vehicle communications. Also, Amini et al. (2019) addressed in their study how much car driver behaviour would be different while following a motorcyclist compared to other cases, along with a segment of an urban highway. Puan et al. (2020) investigated in their study the safe following distance adopted by drivers on expressways at different operating speeds. They developed models and studies varying in their goals and ranging from simulation modelling approach to experimental approach including analysis of complex mathematics. Meanwhile, there has been an additional lane constructed on the highways to provide edge in flow of smooth traffic, so that vehicles could be increased. The average speed, therefore, may increase due to smooth traffic flow. Such phenomenon has been observed along Batu Pahat to the road of Ayer Hitam, which was advanced since 2005 to four-lane highway.

Kuwait is an emerging economy with state-of-the-art road infrastructures and well-made roads. This is, however, not consistent with the level of traffic safety as the country fares among the worst in the GCC region in terms of road accidents and injuries. Traffic congestion and road safety, therefore, have turned to attain increased importance among issues in Kuwait. To educate drivers, appropriate research is required to understand their behaviours that are associated with car crashes. The epidemiological features of the accidents are to be identified so as to set a framework for further evaluation (Hajeeh, 2012). Driving behaviour has to be related to or influenced by other factors such as traffic law enforcement, education, lifestyle, and external factors pertaining to the environment, road infrastructure, traffic flow, vehicle characteristics, and weather conditions. The present project focusses on traffic flow speed and drivers' car-following behaviour for investigation under impact of weather conditions.

Weather in Kuwait is typically of an arid climate, with long dry summers and brief warm winters. Storms are common phenomena that impact visibility and road surfaces in Kuwait, thereby affecting driver response and traffic flow. During winter, storms and fog contribute to impairing visibility range of 500 meters or below. Not enough work is being done to investigate impact of the storm induced adverse weather on road accidents due to absence of sufficient data. Appropriate data collection and analysis methodologies on driver behaviour specific to tailgating or car-following and traffic flow are to be adopted. Simulated car-following models and traffic flow models can be studied under this specific context. So, this paper aims at recognizing headway of cars along multilane highway of Road 40 in Kuwait and finding out linear regression models, so that the relation between speed and headway could be presented. In this paper, vehicle following headways were analysed based on operating speed and time of headway with this multilane road. In addition, this research emphasized on characteristics of traffic flow such as headway, speed, and volume.

2. LITERATURE REVIEW

Various researches have demonstrated that vehicle following distance depends on a variety of factors including personality, behaviour of a driver, traffic situation, and road geometry features (Liu et al., 2018; Puan et al., 2020; Ling, 2006; Taieb & Shinar, 2001). Furthermore, several car following models were designed to explain interaction among adjacent cars in the identical or same lane covering dynamics of traffic. Other studies have given detailed applications and descriptions of speed and headway relations in road traffic safety and road capacity studies and analysis. Liu et al. (2018) introduced a method to extend Intelligent Driver Model (IDM) to support imperfections of model driver and multiple lanes. The required structures are attained in a stimulator consisting of 3D stereoscopic driving in a CAVE from an experiment and later transferred to Car Following Model implementation in SUMO (Traffic stimulator). Encouraging consequences related to the overall impact of Advanced Driver Assistance Systems (ADAS) are attained, implementing various hundred simulation runs of numerous situations. It is supposed to be mentioned that the BM structure needs more computational resources as a CFM is not measured at one time per car but as much time as the BM covers cells.

The headways and speed information of cars, which were combination of unrestrained and restrained cars, are gathered during the research. In the analysis, only the data of headway for impeded or restrained vehicles are taken into consideration. Hunt says that no particular way of differentiating the following car has entered in influence zone or the leader has impeded following the mainstream of traffic (Yu & Wang, 2014). Nevertheless, 1994 Manual of Highway Capacity states that a vehicle is impeded by its leader within 5 seconds headway or less, while all headways were gathered; only those vehicles were used in the analysis, which had headway of 5 seconds or less than 5 seconds. In general, speed or vehicle longitudinal controls can be characterized into two main commands: car-following and free flow. The meaning of free flow states that the behaviour of a driver related to speed control is not affected by downstream or upstream driving situations and is voluntary (Ling, 2006). In reality, it can be applied where little interaction is found in vehicles such as when there are some other cars but are farther from a driver's vehicle or there are no other vehicles involved. In capacity analysis process, free-flow driving is critical for basic freeway sections and multilane highways illustrated in the Manual of Highway Capacity. Generally, the relations between speed and headway are in regression model form as shown in Equation (1) (Chakrabarty & Gupta, 2013).

$$H = A0 + A1V \quad (1)$$

The above equation is described as follows: H denotes to distance headway (m), V denotes to the vehicle's speed (meter/second), A0 denotes to length of vehicle (meter), and A1 denotes to reaction time of driver (s). Halden passed out a REVS Scottish model based on singular carriage way section for traffic (Hoogendoorn et al., 2003). This model is based on the assumption that car following distance does not differ with its speed, and all the vehicles have identical length. The relationship of vehicle following distance is described in equation (2).

$$H = L + 10 \tag{2}$$

In this equation, H denotes to the headway measured from rear to rear, and L denotes to the length of vehicle. The length of vehicle is considered around four meters for a car. All speeds are assumed as equal in equation (2). This equation is unable to interpret actual behaviour of drivers. In 1997, Hunt conducted a study of drivers following behaviour for singular carriage way roads of Great Britain (Hunt, 1997). He found four kinds of cars following headway relations in the form of the following four equations:

Car succeeding car, $HCC = 2.124V - 4.31$ (3)

Car succeeding HGV, $HCH = 2.052V + 1.156$ (4)

HGV succeeding HGV, $HHH = 2.79V - 3.997$ (5)

HGV succeeding car, $HHC = 2.854\ V - 8.15$ (6)

where (H) denotes the measured distance from forefront (m), and (V) denotes the speed (meter/second). Goodwin went through some of the research works that addressed the effects of weather on the flow of traffic, emphasizing on arterial road ways along with signals (Goodwin, 2002). It was found that Inter-car spacing and driver headway increased with weather forecasts with acceleration rates and reduced speeds. Timing plans' effectiveness could be affected because of worst weather conditions such as high winds, sleet, rain, hail, smog, fog, rain, smoke, and lighting extreme temperatures. He also concluded that travel time was increased up to 50% due to worst weather conditions. Car stops were increased by 14% during adverse weather situations in comparison with normal conditions. Keeping in view these adverse weather conditions, drivers must make sure that they are in the right flow to avoid any danger. Execution of signal time plans in relation to weather was suggested to facilitate the response of driver, and traffic speed was increased by 12% (Rama & Kulmala, 2010).

Another paper given by Kulmala and Rama explained the impact of Variable Message Signs (VMS) and Dynamic Message Signs (DMS) on driver's car following behaviours. It was suggested to give warnings to drivers about adverse road conditions and to show a solution of maintaining a minimum of 30% distance among cars. In the end, it was shown that car speed was reduced by 1 to 2 km/hour. Apart from car-following car speed, the DMS implements some other behavioural alterations between drivers. It emphasized drivers to focus more on the cues for hazards, which are likely to be addressed. In this case, potential hazards will include the adverse road conditions, so that they could remain cautious. Identical researches covering advisory signs have displayed developments in rear-car crash accidents, reducing tailgating and headway distance (Kong & Guo, 2016). To analyse the car headway, appropriate statistical ways were used including Kolmogorov-Smirnov test, chi-square testing, and maximum likelihood estimation. For truck-truck and car-car headway types, log normal model was found as accurate. Furthermore, their impact on traffic density and rate of traffic flow was investigated in the research (Abdullah, 1989). For present purpose, useful implications should be adopted on research approach.

Kuwait is such an emerging country with new and developed traffic infrastructure and good roads, yet the country fares among the worst, even highest within the GCC region and Middle East with 28 fatalities per 100,000 vehicles (Hajeeh, 2012). These accidents are found by the Kuwait Ministry of Health to be the primary causes of injury and death, so much so that it ranked third in being the cause of death during the period of 1998–2002, right behind heart disease and neoplasm (Ministry of Health, 2002). Interestingly, the main factor that contributes to traffic accidents in the Middle East is found to be human error, as high as 90 percent (Al-Matawah, 2015). The death, disability, and socioeconomic ramifications caused by road accidents are thereby profound and, yet, can be prevented by using appropriate remedial measures. Two main factors need to be considered for curbing the said problem (Al-Matawah, 2015):

1. The physical and human characteristics of the road or traffic environment, or a country.
2. A good data collection and analysis system for road accidents.

The above steps preclude the need to evaluate the effects of concerned countermeasures in line with the approaches following five E's and two C's addressed earlier. In several countries, these approaches have been adopted and implemented to effectively observe a reduction of accidents in terms of their frequency and severity. This has been mainly targeted in changing the behaviour and attitudes of drivers. Al-Matawah led a similar study focused on Kuwaiti drivers and their attitudes and behaviour under influence of factors including social status, gender, age, nationality, level of education, and more. It is important to understand the underlying problem of driver behaviour in general as well as the problem in particular parlance to Kuwait. Some studies are dedicated to understanding the trends of driver behaviour in terms of using belts, smoking, or using mobile phones while in motion (Al-Matawah, 2015).

Al-Rukaibi et al. (2002) had done a research to identify this kind of trend among young Kuwaiti drivers. Their methodology included PI surveys using a well-defined questionnaire involving 1467 subjects of young drivers that were randomly selected. The parameters used in the study were belt use, smoking, socioeconomic conditions, driving experience, and previous encounters with road accidents, the interrelationships between which were investigated. The study found that driving was safer among the young female drivers compared to young male drivers, as the latter were also found to smoke while in motion and use seat belt less while driving. The paper provided a list of measures to be considered as recommendations for lesser traffic accidents and more road safety in Kuwait (Al-Rukaibi et al., 2002).

In Kuwait, the road conditions are pretty good, but it still faces high number of road accidents. The various other reasons that account for these accidents include reckless driving behaviour of drivers, ignorance of traffic rules and regulations, old vehicles, and faulty licensing systems (Hajeeh, 2012). In 2013, the total numbers of traffic violations were found to be around 3.4 million, which increased in 2014 to 6.5 million (Hajeeh, 2012). This increased number of traffic violations poses a serious threat. Climate conditions, such as dust storms, result in low visibility on roads and hence contribute to occurrence of road accidents.

3. METHODOLOGY

3.1 Data Collection

The study was conducted at multilane road at Road 40, Kuwait. The road connects multiple areas for various industrial areas, urban and governmental regions. The location of the road in Google map is shown in Figure 1.

Figure 1. King Fahad Bin Abdul Aziz Road (Road 40). (A) Google Satellite view. (B) Map of studied part of the road showing location of RTMs device. (Google Map).

The road has two directions having total of six main lanes on each side, and the upper and lower sides are 120km/hour and 80 km/hour, respectively.

The data was collected at the road by using Remote Traffic Microwave Sensor (RTMS Sx-300) device, which is known as a radar device particularly used for monitoring traffic. The data was gathered in the period from 29 December 2018 to 5 January 2019, which is a cold period in Kuwait. Auto-scope RTMS Sx-300 Footprint is shown in Figure 2.

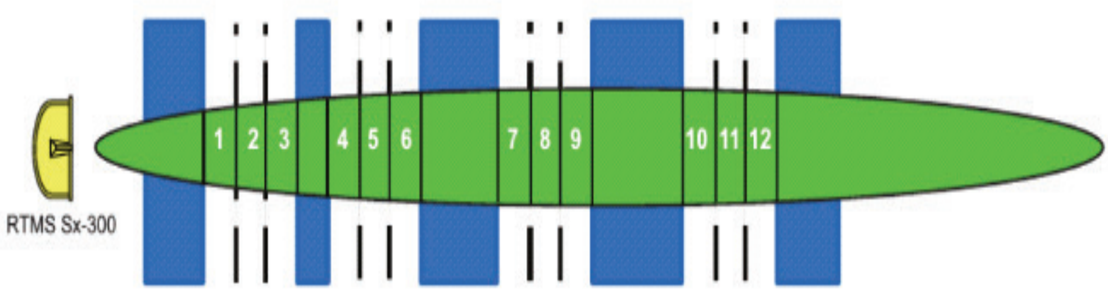

Figure 2. Auto-scope RTMS Sx-300 Footprint.

In Figure 2, the device is set to measure the length, time of pass, and speed of vehicles. The device classifies automatically vehicles' types based on length. The device is maintenance-free virtually and is all-weather accurate. .and length of vehicles were collected for all lanes ,The data such as headway,speed

3.2 Data Analysis

The gathered data were analysed and classified based on the following criteria:

- Car percentage for every speed interval.

- Car's speed at daytime (30 minutes each).
- Speed intervals versus average headway.
- Car following pattern versus average headway for combined lane.
- Speed for every followed pattern versus average headway.

The headway data was grouped into 10 seconds interval. The gathered data were coded in Equation 1 to obtain the relationship between headway and speed. The density plot was then illustrated for various vehicle categories, which are Small, Medium, Large, and Truck.

4. RESULTS AND DISCUSSION

4.1 Traffic Composition

The traffic composition on the road is shown in Figure 3. It could be asserted 10% of the traffic consist of trucks, 29% consist of large-sized vehicles, 21% of small-sized vehicles, and a substantial rate of 40% of traffic includes medium-sized vehicles.

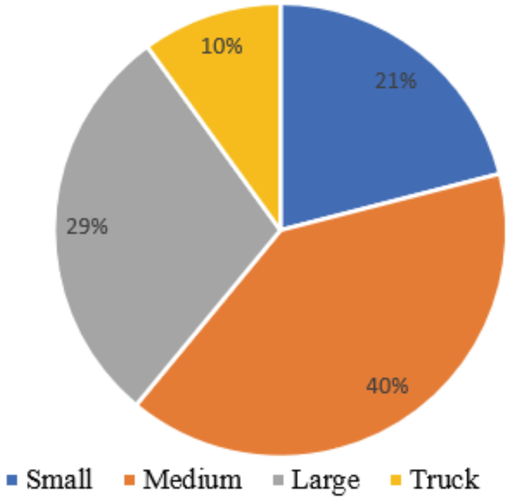

Figure 3. Traffic composition on the Road 40.

4.2 Density Plot for All Lanes

A density plot can be defined as a representation of the distribution of lanes' data (headway, speed, and length). It utilizes a kernel density estimate in order to demonstrate the probability density function of model variables. Figure 4 shows density plot of speed for large vehicles.

Density plots have been drawn in this study in order to show the distribution of speed, length, and headway for all vehicle types in each lane. It provides a descriptive view of the data such as mean and standard deviation as shown in Figure 4. Samples of the density plots are included in Figure 4, without including all density plots, because it is not the issue here.

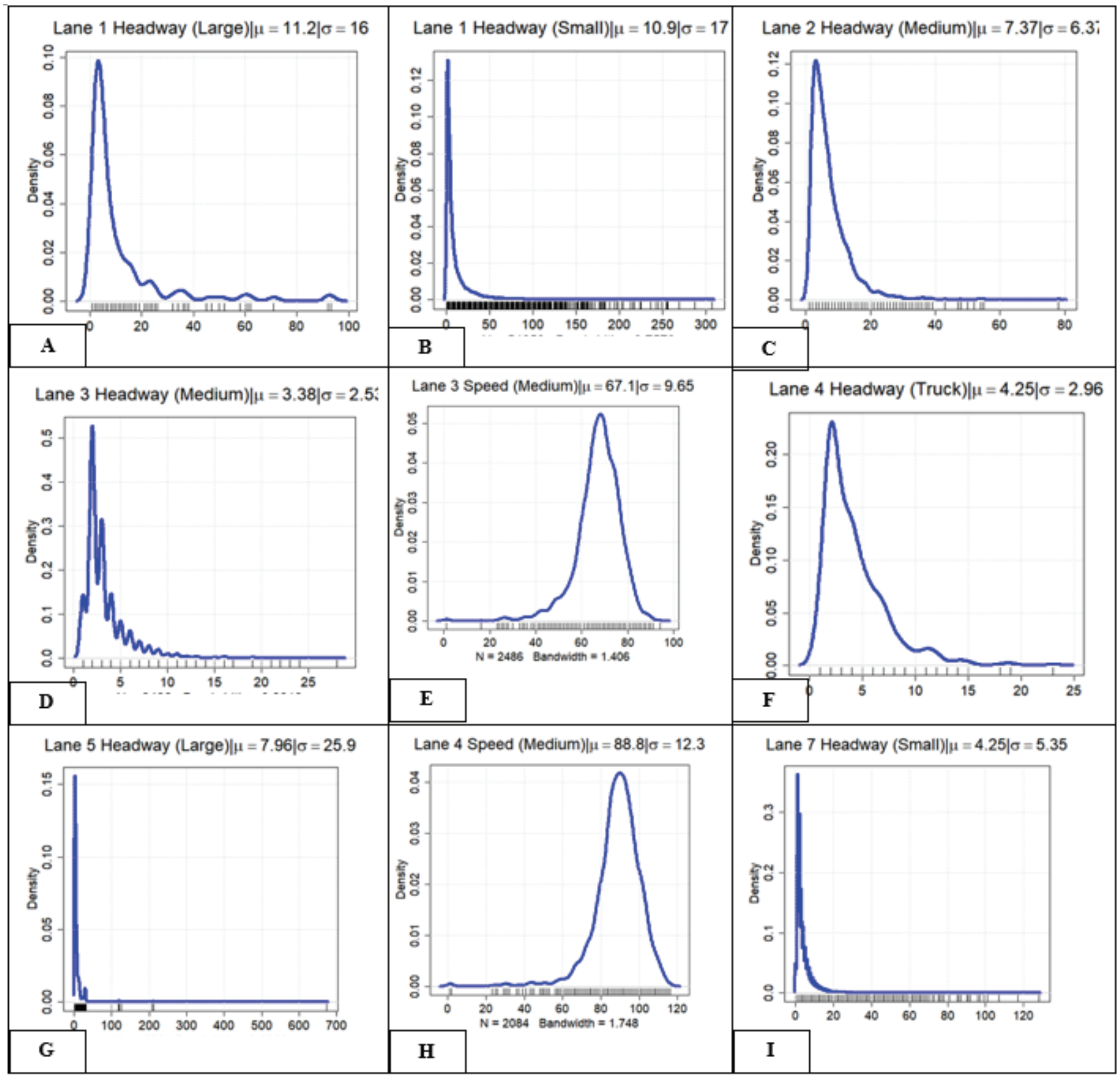

Figure 4. Samples of density plots. (A) Lane 1 for Large vehicles. (B) Lane 1 small vehicles. (C) Lane 2 medium vehicles. (D) Lane 3 medium vehicles. (E) Lane 4 medium vehicles. (F) Lane 4 for trucks. (G) Lane 5 for large vehicles. (H) Lane 4 for medium vehicles. (J) Lane 7 for small vehicles.

4.3 Percentage of Vehicles for All Speed Intervals

The streaming flow relies on the average pace of a vehicle moving on the route as stated in a substantial number of studies (Song & Wang, 2010). The proportion of vehicles in line with their speed during day and night is illustrated in Figure 5.

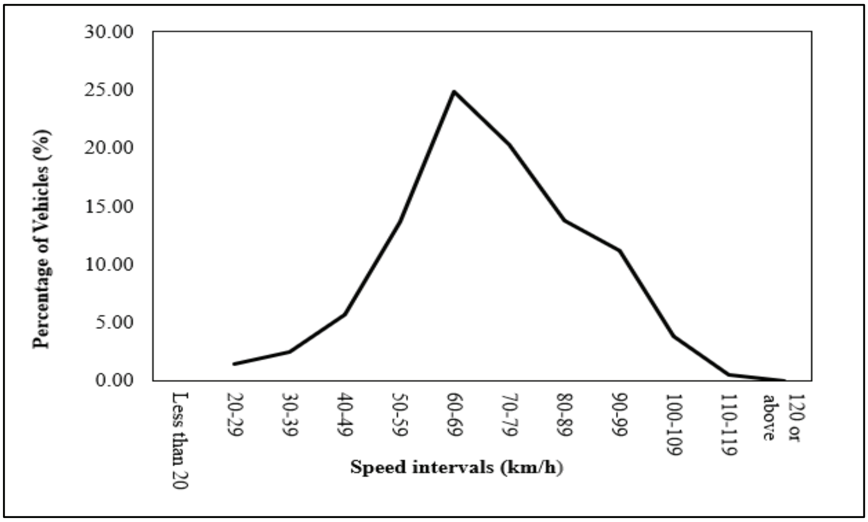

Figure 5. Average vehicle speed on the Road 40.

As shown in Figure 5, it depicts that approximately 24.87 % of vehicles move amidst the speed of 60 to 69 km/hr, whereas 88.37% of vehicles move at 50 to 120 km/hr. At the hours of the day, these vehicles move relatively slower. Additionally, it has been estimated that just 0.08 % of vehicles surpass the highest pace boundary of the road (i.e., 120 km/hour). Ultimately, it could be stated that the vehicles are disseminated as depicted in Figure 4, where the pace interval 100–110 (km/hour) depicts greater proportion of vehicles over the line of normal distribution.

4.4 Speed of Cars At Daytime

The pace of vehicles is variant during the day, due to several reasons like overgrowing and rush hours. The average pace of vehicle on the assessed road during day and night has been depicted in Figure 6.

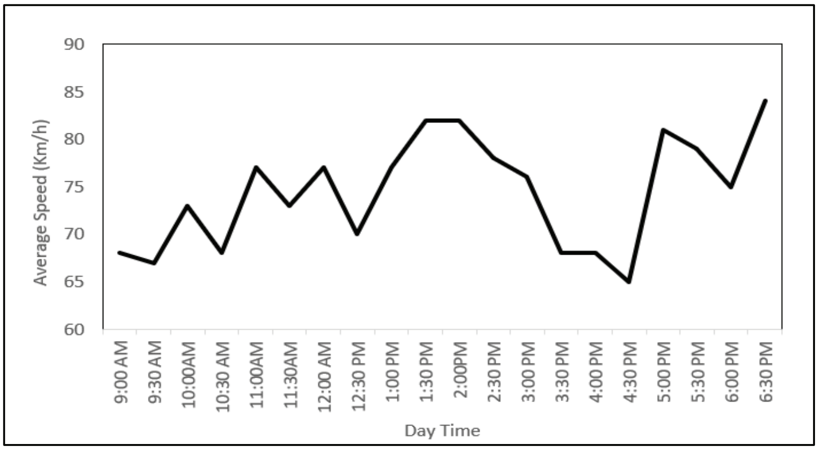

Figure 6. Average vehicle speed at different day time.

As demonstrated in Figure 6, the pace of vehicles varies nearly amidst 68 km/hr to 84 km/hour. It could be observed that the speed/pace of vehicles has been substantially declined during 6 pm till 12 Am, which is possibly a result of jamming/crowding in Kuwait during this time. It can be noted that all vehicles in other speed intervals have safe headway (above 2 seconds).

4.5 Average Headway Versus Speed Intervals

A majority of studies asserted that the association amidst average vehicle speed and recorded headway is generous. The potential action was that drivers are ought to enlarge the gap amidst their vehicle and other vehicles whilst at greater speed in order to evade accidents. The average headway for different pace intervals has been demonstrated in Figure 7.

As presented in the above figure, vehicles with greater speed have more headway duration (nearly eleven seconds) that comply with the estimated notation given by other investigators (Chakrabarty & Gupta, 2013; Hoogendoorn et al., 2003; Yu & Wang, 2014).

It could be maintained that all vehicles in other speed gaps have a secure headway (greater than 2 seconds). The assessed scenario in this study depicts that the tailgating of drivers in Kuwait is disrupted as tailgating is a major contributing factor for accidents, where the headway for all vehicles is petite than two seconds. This specifies that the emerging studies in this sector in Kuwait require more amendment.

As per the regulations, the unsafe headway amidst vehicles is two seconds (Song & Wang, 2010). Headway more than that is important in order to maintain a secure on-road setting for drivers.

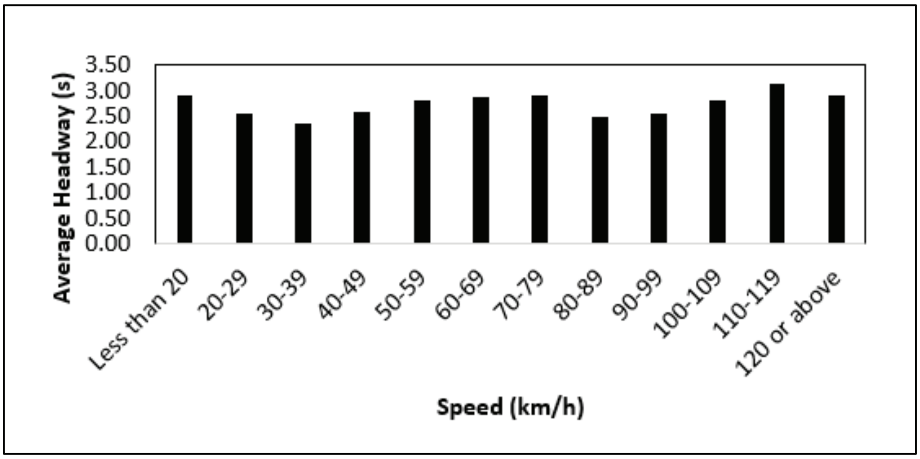

Figure 7. Average headway versus speed intervals (seconds).

Vehicles were segmented into four types, which are Small vehicles (0–6 m long), Medium vehicles (6–10 m long), Large vehicles (10–20 m long), and Trucks (above 20 m). It can be noted that the headway does not relate to the speed as predicted. The reason behind this unexpected behaviour is the lane mix and the behaviour of drivers at high speed.

According to this categorisation of information, the following sixteen arrangements could take place as illustrated in Table 1.

Table 1. Available Vehicle following pattern.

Vehicle Type	Followed by			
Small	Small	Medium	Large	Truck
Medium	Small	Medium	Large	Truck
Large	Small	Medium	Large	Truck
Truck	Small	Medium	Large	Truck

Headway average vs speed average of vehicles for every vehicle following stream (every car model with pace greater than 15 kilometre per hour)

4.5 Results Without Vehicle Classification for All Lanes

Here, a model was built to find linear relationship between average speed and average headway for all following patterns and all lanes, as shown in Figure 8.

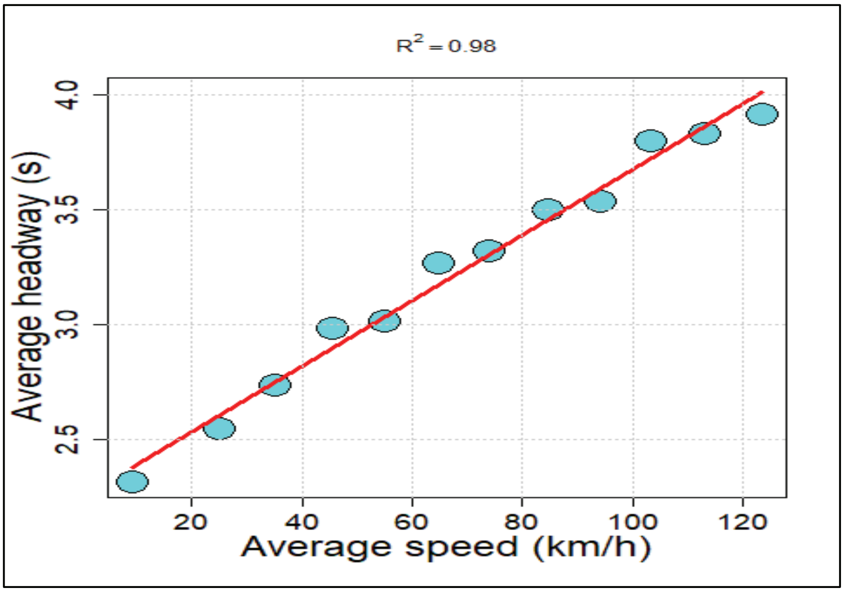

Figure 8. Average speed and average headway for all following patterns and all lanes.

Figure 8 shows that the relationship between average speed and headway is linear, where the value of R^2=0.98. Model can be represented by the following formula.

$$H = A_0 + A_1 V \tag{7}$$

$$H = 2.249 + 0.014\ V \tag{8}$$

4.5.1 Small-Sized Vehicle

Figure 9 depicts the headway average in contrast with average pace of small-sized vehicles in the streams. In order to identify a direct association for every pattern of small-sized vehicles, a direct placement of information has been developed as illustrated in Figure 9. The brief of association for following pattern headway per second for small-sized vehicles at varying pace (hr/km) could be found in Table 2.

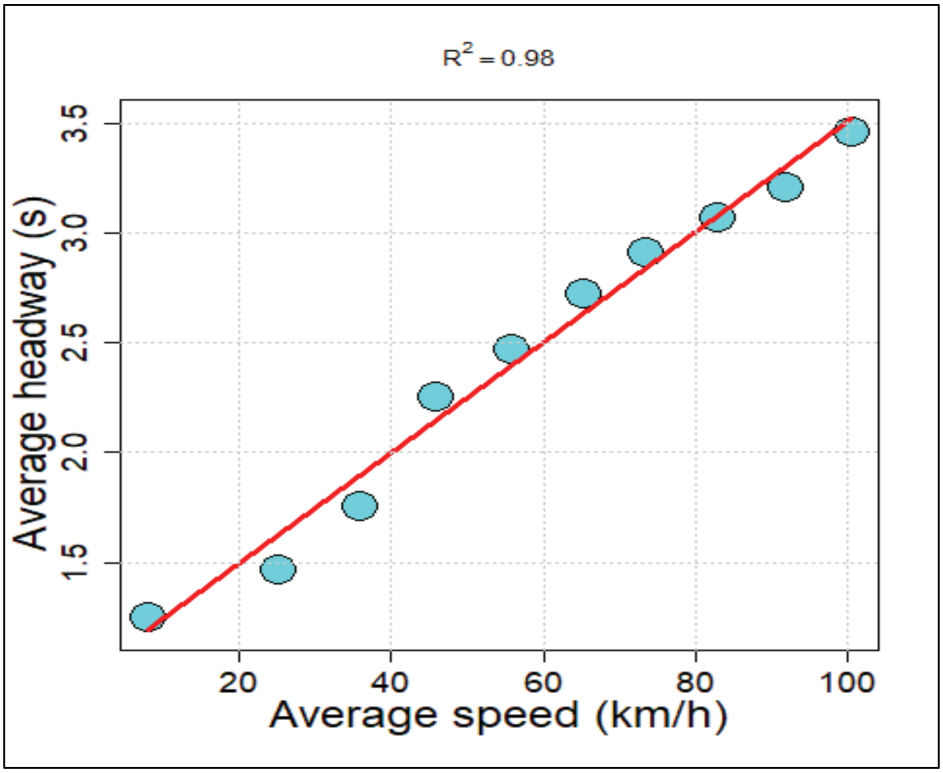

Figure 9. Headway average/Sec at varying following vehicle speed for joint lanes of small-sized vehicles.

Table 2. Brief of association for following pattern headway per second for small-sized vehicles at altered speed (hr/km).

Following type	Headway, $H = A_0 + A_1V$		
	A_0	A_1	R^2
Small – Small	0.987	0.025	0.98
Small – Medium	2.30	0.0058	0.94
Small – Large	2.738	0.007	0.98
Small – Truck	2.175	0.008	0.92

4.5.2 Medium-Sized Vehicle

The headway average in contrast with speed average of vehicles for medium-sized car pattern could be observed in Figure 10. To identify a direct association for every pattern of medium-sized vehicles, a direct placement of information was developed, which is presented in Figure 10.

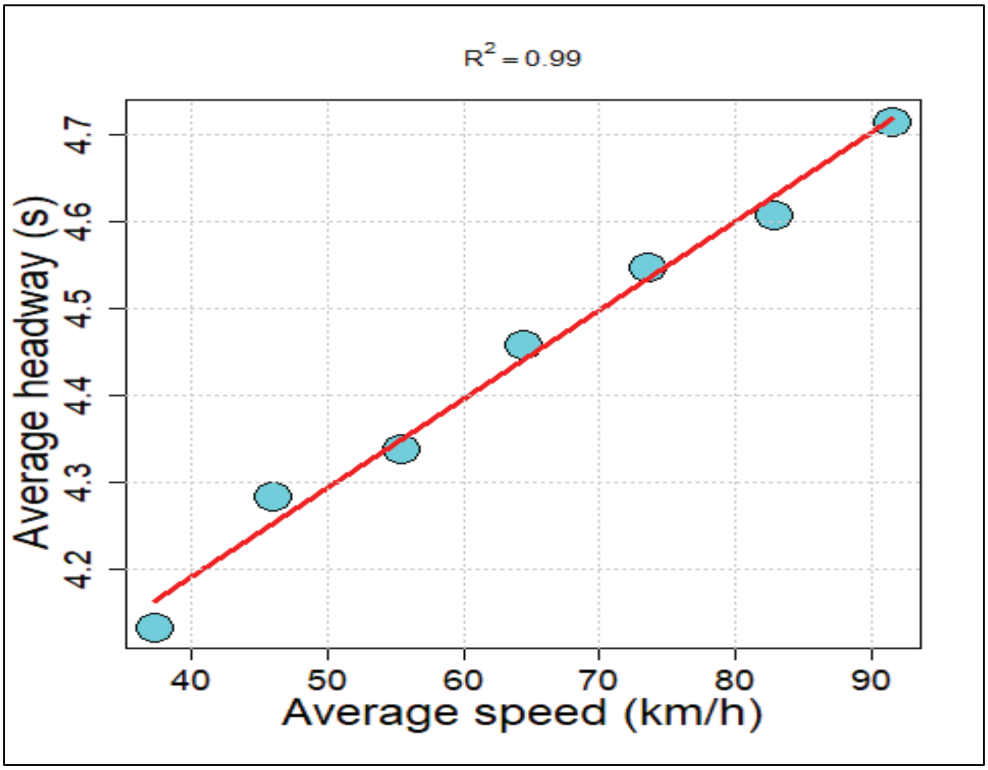

Figure 10. Headway Average per second at varying vehicle pattern for joint lanes of medium-sized car.

The brief of the associations in average headway per second of medium-sized vehicles at varying speed hr/km could be observed in Table 3:

Table 3. Brief of association for following pattern headway per second for medium-sized vehicles at altered speed (hr/kmwhere (H) stands for 'headway in seconds' and (V) denotes average speed of vehicles – km/hr.

4.5.3 Large-Sized Vehicle

The headway average in contrast with speed average for large-sized vehicle pattern could be observed in Figure 11. To identify a direct association for every pattern of large-sized vehicles, a direct placement of information was developed, which is presented in Figure 11.

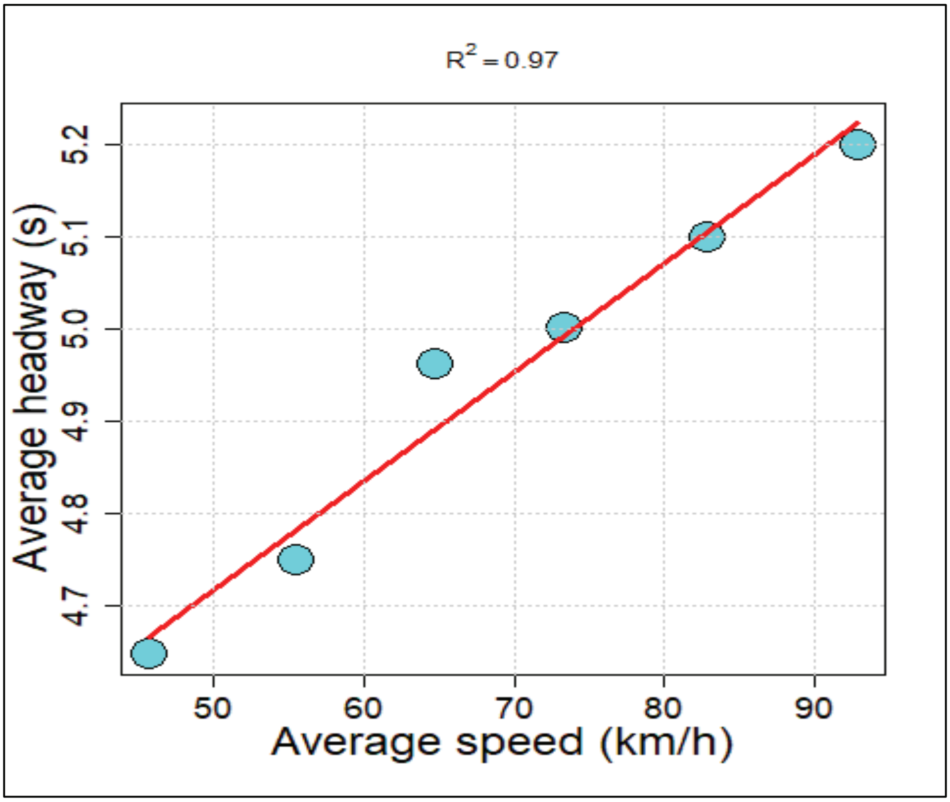

Figure 11. Headway average per second at varying vehicle pattern for joint lanes of large-sized car.

The brief of the associations in average headway per second of medium-sized vehicles at varying speed hr/km could be observed in Table 4.

Table 4. Brief of association for following pattern headway per second for large-sized vehicles at altered speed (hr/km).

Following type	Headway, $H = A_0 + A_1V$		
	A_0	A_1	R^2
Large – Small	3.78	0.01	0.97
Large – Medium	3.061	0.009	0.88
Large – Large	2.69	0.039	0.88
Large – Truck	3.529	0.021	0.94

where stands for ‘headway in seconds and denotes average speed of vehicles – km/hr.

4.5.4 Trucks

The headway average in contrast with speed average for large-sized vehicle pattern could be observed in Figure 12. To identify a direct association for every pattern of truck-sized vehicles, a direct placement of information was developed, which is presented in Figure 12.

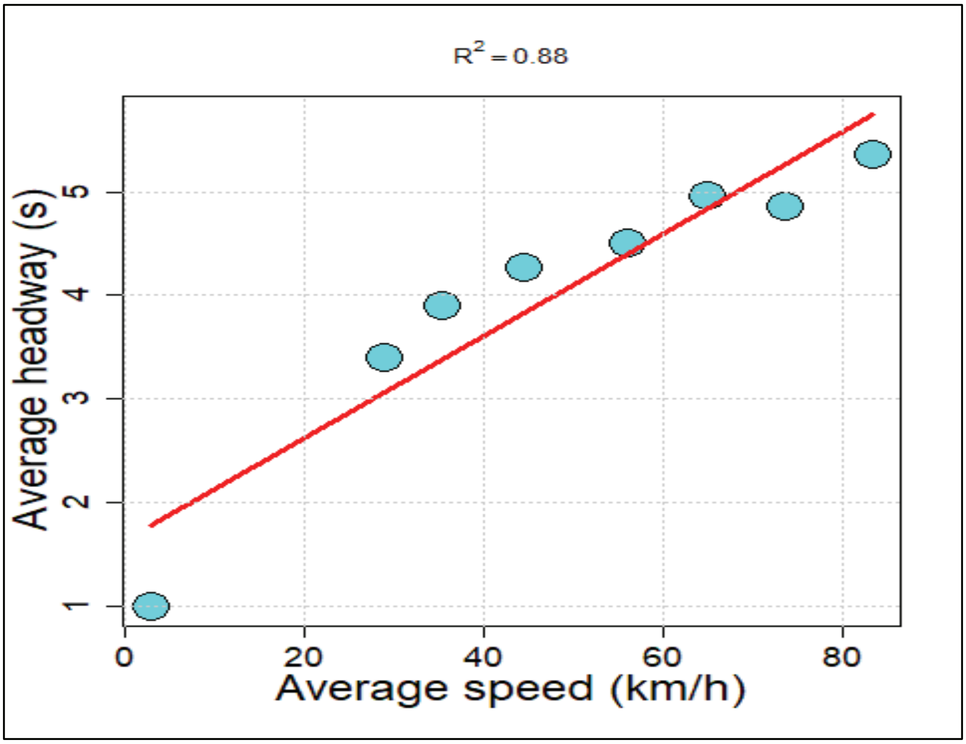

Figure 12. Headway average per second at varying vehicle pattern for joint lanes of truck-sized car.

The brief of the associations in average headway per second of medium-sized vehicles at varying speed hr/km could be observed in Table 5:

Table 5. Brief of association for following pattern headway per second for truck-sized vehicles at altered speed (hr/km).

Following type	Headway, $H = A_0 + A_1V$		
	A_0	A_1	R^2
Truck – Small	2.35	0.025	0.88
Truck – Medium	3.3946	0.002	0.6
Truck – Large	3.207	0.009	0.59
Truck – Truck	2.355	0.025	0.94

Table 5 shows that the values of R2 are logical. Thus, the relationships between headway and speed are also logical. All terms have a positive sign that implies that a driver would keep a longer following distance with the leader as the speed increases. The coefficients, on the hand, appear to agree with a general understanding that an average driver reaction is in a range of 1 to 3.4 seconds. The good R2−values are larger than 0.80, and for models 1 and 4 (Truck –Small) and (Truck-Truck), they provide a sound basis for the acceptance of the models to represent the behaviour of the drivers studied road.

5. CONCLUSION

The behaviour of a driver is found to be a critical element and the main cause of road accidents. Drivers at a number of levels can manage accident possibility; nonetheless, it could be helpful if the obtained information is scrutinized to be an element of drivers' actions in Kuwait. The aim of this paper is to identify the association amidst pace/speed as well as headway between different cars on highways with multilanes in Kuwait. The study depicts that nearly 24.87% of the vehicles move at a pace amidst 60 to 69 kilometres per hour. Additionally, the vehicles were segmented according to different kinds, i.e., Truck, Small-, Medium-, and Large-Sized Cars, in order to find the impact of following pattern on the vehicle average. It has been found that no significant association remains amidst the type of following pattern and the headway. This finding complies with conclusions drawn by many existing explorations, which declare that just the weather, driver's mood, and road conditions influence vehicle headway. Ultimately, a liner regression of data was developed to calculate a liner equation that shows the headway average as an element of speed for sixteen diverse following patterns. It has been recognized that an association could be supposed in medium-sized and small-sized vehicles. It has been observed that headway average could be placed in a linear equation for large, medium, and small as well as truck vehicles. It is worthy denoting that when data is bigger, the exactitude of a study is enhanced. Findings from each model of liner regression have more than 80% confidence level. The model of regression is deliberated as statistically significant, where the R (square) figures lie amidst 0.99 till 0.6. As per the findings, speed is the key influencing factor for headway value. The type of car does affect headway with drivers behind Heavy Good Vehicles and cars at the similar speed. According to the data, cars are identified to keep more headway when behind Heavy Good Vehicles in contrast with when behind other cars. These results will help the drivers understand their behaviour that are associated with car crashes, thus increasing road safety awareness and reducing traffic congestion in Kuwait.

6. REFERENCES

Abdullah, M. M. 1989. Dust storm phenomena and their environmental impacts in Kuwait, PhD Thesis, University of Glasgow, UK

Al-Matawah, J. 2015. Appraisal of Road Safety in GCC Countries, College of Technological Studies, Kuwait.

Al-Rukaibi, F. Ali, M. and Aljassar, A. (2002) Traffic Safety Attitudes and Driving Behavior of University Students: Case Study in Kuwait, Journal of the Transportation Research Board, https://doi.org/10.3141/1969-11

Amini, E. Tabibi, M. Ramezani, E. & Abhari, K. 2019. A vehicle type-based approach to model car following behaviors in simulation programs (case study: Car-motorcycle following behavior). IATSS Research.

Chakrabarty, N. & Gupta, K. 2013. Analysis of Driver Behaviour and Crash Characteristics during Adverse Weather Conditions, Procedia – Social and Behavioral Sciences, 104 (2): 1048-1057.

Goodwin, L.C. 2002. Weather Impacts on Arterial Traffic Flow [Online] Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.587.9563&rep=rep1&type=pdf (Accessed: 15 March 2019)

Hajeeh, M. A. 2012. Traffic Accidents in Kuwait: A Decision Making Analysis, International Journal of Applied Mathematics and Informatics, Issue 2, Volume 6.

Hoogendoorn, S. P., Van Zuylen, H. J., Schreuder, M., Gorte, B. and Vosselman, G. 2003. Microscopic Traffic Data Collection by Remote Sensing. Transportation Research Record: Journal of the Transportation Research Board. 1855(1): 121-128.

Hunt, J. G. 1997 . Vehicle Headways in Urban Areas. Traffic Engineering and Control, 32 (10): 458–465.

Kong, D. & Guo, X. 2016. Analysis of car headway distribution on multi-lane freeway considering car–truck interaction, Sage Journals, April 27. doi: 10.1177/1687814016646673

Ling, L. S. 2006. Investigation of Driver's Car Following Headway on Two-Lane Highway. Universiti Tun Hussien Onn Malaysia, Batu Pahat.

Liu, L. Li, C. Li, Y. Peeta, S & Lin, L. 2018. Car-following behavior of connected vehicles in a mixed traffic flow: modeling and stability analysis. Transportation Research Part B: Methodological.

Ministry of Health. 2002. Annual Statistical Abstract, The State of Kuwait, Edition 39.

Puan, O. C. Mohamed, A. Idham, M. K. Ismail, C. R. Hainin, M. R. Ahmad, M. S. A. & Mokhtar, A. 2020. Drivers behaviour on expressways: headway and speed relationships, IOP Conference Series: Materials Science and Engineering.

Rama, P. & Kulmala, R. 2010. Effects of variable message signs for slippery road conditions on driving speed and headways. Transportation Research F, 3(2): 85-94

Song, M., & Wang, J.H. 2010. Studying the tailgating issue in Rhode Island and its treatment. Proceedings of the 51st Annual Transportation Research Forum, Arlington, Virginia, 55-71.

Taieb, M. & Shinar, D. 2001. Minimum and Comfortable Driving Headways: Reality Versus Perception. Ilumain Factors, 43: 159-172.

Yu, C. & Wang, J. 2014. Drivers' car-following correlative behavior with preceding cars in multilane driving, Intelligent Cars Symposium Proc., IEEE, DOI: 10.1109/IVS.2014.6856494.

Zhao, H. He, R. & Ma, C. 2018. An Extended Car-Following Model at Signalised Intersections. Journal of Advanced Transportation.