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Implementation of chosen risk index during car-following behaviour under wet weather condition

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Abstract. This study aims to examine the effects of wet weather on accident consequence during car-following behaviours. The study analysed drivers' car-following headway on two-lane highways along passing and no passing zones associated with passenger cars and heavy goods vehicles (HGV). The speed and time gap of more than 200,000 vehicles were recorded during dry and wet weather at 4 specific sites in Peninsular Malaysia using Automatic Traffic Counter with pneumatic tubes. Rainfall data were acquired from the nearest rain gauge station. Chosen Risk Index (CRI) was used to characterize and evaluate the accident consequence caused by wet weather incidence. The results disclose that the drivers are more cautious to avoid accident severity during wet weather compared to dry weather irrespective of vehicle type and highway features. This result is evidenced by lower CRI values during wet weather compared to dry weather. The data shows that under wet weather condition the speed that gives lower risk of accident is in the range of 47.3 to 73.9 km/h and 56.5 to 74.0 km/h i.e. which associated with CRI values in the range of 0.60 to 0.75 and 0.53 to 0.79 at passing and no-passing zones, respectively. These findings are useful for the improvement of roadway design and the implementation of traffic safety interventions.

1. Introduction

Vehicles crashes are perceived as complex events which are often influenced by roads geometry, driving behaviours and driving environments. Among the diverse contributing factors of car collisions, weather conditions play predominant role. Especially that precipitation and wet weather occurrences during driving deteriorate drivers' visual equity as well as pavement skid resistance, leading to negative impact on the driving performance and traffic safety [1-4]. Such driving environment with short sight distance and long stopping space leads to inaccurate judgement of safe following behaviour made by the drivers while following leading vehicles at particular speed [5].

In the traffic stream, unsafe car-following distance among drivers not only increase the risk of rear-end collision but also raise the possibility of several other types of accidents [6, 7]. Especially, if the close-following manoeuvres are coupled with accelerated overtaking or passing manoeuvres, the risk factors for accidents increase [8]. This basic aspect of driving performance is called drivers' car-following behaviour. Therefore, to develop safe roadway design and strategies for road accidents mitigation, in-depth knowledge and understanding of drivers' car-following behaviour is mandatory.

On two-lane highways, a high traffic volume on a wet day with poor visibility and little pavement friction often limits the chances for overtaking manoeuvres. This in turn builds up rapid platoon wherein

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an adjacent group of vehicles travel in same speeds [9]. In those situations, the drivers' decision to initiate, continue, or complete a passing manoeuvre is even more complex than the decisions involved in car-following. During passing process, the drivers may reduce the headway to a point where they cannot maintain the safe distance with the car ahead, leading to an increase in the rear-end crash probability. To control the errors, the drivers should know how to judge the speed of overtaken vehicle and the oncoming vehicle. Thus, drivers must be able to predict accurately, the gap and time to overtake a vehicle. Certainly, a small error while overtaking could end up with a fatal accident. Besides, for safe passing manoeuvre, drivers need to judge the speed and acceleration potential of their vehicle, the speed of the leading vehicle, the speed rate of the closure of the approached vehicle, and the presence of an acceptable gap in the traffic stream [10].

Although, careful driving depend on the risk perception to maintain a safe speed and following headway (the average time interval between successive vehicles), precipitation while driving can considerably elevate the possibility of road accidents, mostly, the rear-end collisions [11-14]. The range of driver adjustment to diminish the accident possibility may extend to the level of trip deferment or cancellation. Some studies suggested that drivers' speed adjustments are usually insignificant and almost always inadequate to fully offset the danger offered by adverse weather [15-19].

Lately, considering the importance of traffic safety management and drivers' awareness, a clear understanding on the relationships between drivers' behaviour and unfavourable weather has become essential. Such knowledge would help highway traffic agencies to build up robust traffic safety management strategy. Traffic safety managements are categorized into three types such as advisory, control and treatment strategies [20]. To achieve its goal, traffic safety management must not only be reactive but also need to be proactive. That is, to include weather warning systems, speed limit administration and vehicles' spacing, as well as improvement in the highway facilities, are also priorities as proactive schemes. Indeed, such strategies must be dynamically adjusted following the already implemented traffic-weather condition to ensure speed adjustment for matching and modifying the level of the perceived risks [21].

Driven by this idea, present study attempts to identify the perceived level of risk caused by wet weather during car-following behaviour in Malaysian two-lane highways, wherein rainfall is most common all over the year [22]. Empirical models were developed to predict how thoroughly the drivers perceive safe following distance during wet weather compared to the dry at passing and no-passing zones. Moreover, the developed models were used to evaluate the perceived accident consequences via the implementation of chosen risk index (CRI) in the range of the speed. To gain insight on the effects of wet weather on drivers' perception of accident risk, comparisons were made between drivers' behaviour at passing and no-passing zones i.e. between close and normal car-following behaviours.

2. Related works

2.1. Drivers' car following model

Drivers' car-following behaviour models are vital for traffic safety because these models describe the adjacent vehicles' interactions in terms of speed and spacing compromise of moving vehicles on the same lane [6]. Over 60 years, various car-following models have been introduced using diverse empirical and mathematical techniques. Empirical car-following models based on real data collection from road sites are called the driver's preferred following distance. They allow having an insight on how driving environment, highway and traffic characteristics influence the complex decision-making process during car-following to cover the human perceptions and individual differences. In general, most studies demonstrate that the relationships between headways and speeds could be presented by a regression model given in equation (1) [9].

$$H = A_0 + A_1 V \tag{1}$$

where, H is the distance headway (in m), V is the speed of vehicle (in m/s), A0 represents the vehicle's length (in m), and A1 is the driver's reaction time (in s).

2.2. Traffic safety during adverse weather

To address the issues related to traffic safety, researchers are rather concerned more with the converse conception of the so-called traffic unsafety. According to [23], it is intricate to present an accurate definition to characterize both concepts because of their greatly subjective and qualitative character. Thus, it is complicated to quantify or predict such notions in terms of adequate parameters. Highway Safety Manual (HSM) has adopted traffic crash as the basis of safety analysis [24]. In this guidebook, the term safety refers to vehicles' accidents' frequency or crash severity, or both, collision types for a definite time frame, specified site, and certain sets of geometric features of roadways and operational circumstances. Therefore, car accidents can be defined as a set of events that cause human injuries or property damages due to the collision of either a minimum of one motor vehicle with another or with a bicyclist, a pedestrian, or an object.

Diverse empirical studies have been conducted to establish some correlation between varied weather conditions and traffic safety related parameters, surrogate measures, vehicle types and so on. Different statistical models and approaches have also been used to predict and assess the weather related effects on the aforementioned parameters and factors on traffic safety. Abdel-Aty, Pemmanaboina [25] used negative binomial regression model to evaluate the influence of wet pavement on crashes. Khorashadi, Niemeier [26] utilized multinomial logit analysis to determine the influence of rainfall on the crashes in the urban and rural areas. Hill and Boyle [27] employed a logistic regression model to examine the crashes under adverse weather conditions (snow, rain or fog) while Jung, Qin [28] examined in details, the drivers' safety issues under wet weather in terms of multivehicle collision frequency and severity wherein micro-simulation modelling was used to authenticate the rainy weather impact on traffic operations. The collision frequency was calculated using negative binomial regression. Besides, the severity of crashes was tested using the sequential logistic regression. Also, log-Inverse Gaussian regression model was used to determine a correlation amid time of collision and the visibility of drivers in the presence of other traffic parameters [29]. The results revealed that visibility reduction could considerably enhance the risk of crash, especially rear-end crashes. Furthermore, it was concluded that the impact of poor visibility and traffic on the risk of crashes could be altered depending on the vehicle types and chosen driving lanes. Another study was conducted to examine the feasibility of using real-time traffic flow data from loop detectors and radar sensors on freeways to forecast the frequency of crashes in poor visibility situation [30].

A method was introduced to study the drivers' risk perception during car-following behaviour under adverse weather conditions (with and without precipitation), where a measure of traffic risk was defined based on empirical data [31]. This measure, known as Chosen Risk Index (CRI), assumes that during car-following situation, the drivers' risk perception could be reflected through their actual behaviour. Additionally, the normal level of collision was the risk chosen during driving at normal situations. Thus, any departure in the selected behaviour compared to the normal situation could express a change in the perceived risk. The CRI is an indicator for the degree of accidents severity. However, the accidents' severities were governed by physical laws, where a car moving with higher momentum (speed × mass) was subjected to stronger impact during accident. Based on traffic data acquired from the inductive loops, the vehicle's weight was used to represent its type (e.g. car or truck). Thus, the vehicle's momentum was used as proxy measure of accident severity to determine CRI. Same approach has been adopted to examine the influence of following vehicle weight and the size of leading vehicle on the driver's car-following behaviour. It was suggested that the length of the wheel-based vehicles being directly related to the vehicle size could be used instead [32].

3. Study area

Skudai-Simpang Renggam Highway (1° 42' 18" N, 103° 53' 31" E) and, Skudai-Kota Tinggi Highway (1° 52' 26" N, 103° 16' 33" E) were chosen for the study as passing and no-passing zone, respectively, as shown in Figure 1. An average rainfall of 2,300 mm average per year was observed in the area. The region experiences two monsoons, the Northeast Monsoon (NEM) (November to March) and the Southwest Monsoon (SWM) (May to September), and two short inter-monsoon seasons in April and October [33]. The data were taken during the monsoon period of 15th November to 14th December, 2016 for both sites.

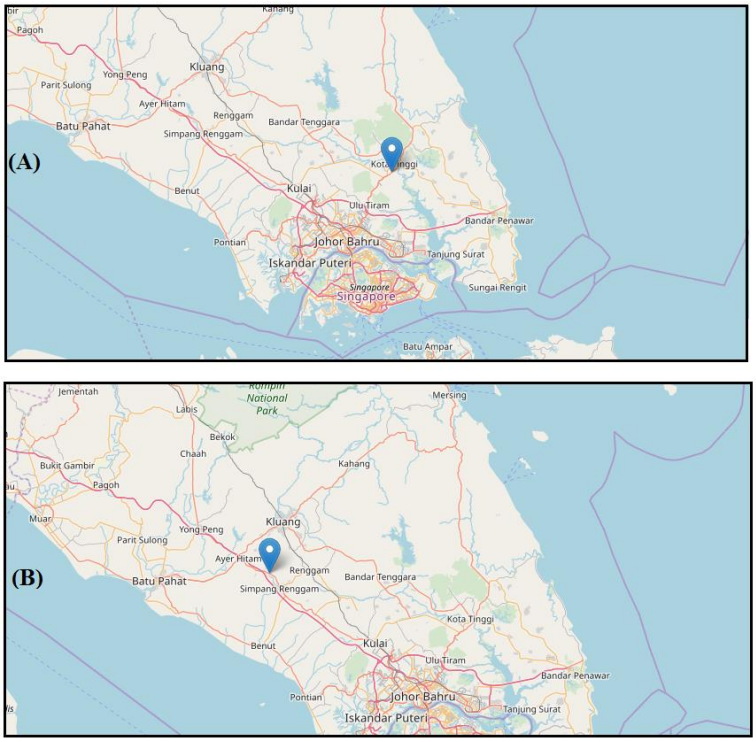


Figure 1. location of study area in Malaysia's southern peninsula (A) Skudai-Simpang Renggam Highway and (B) Skudai-Kota Tinggi Highway.

4. Method

As mentioned earlier, some selected points at several stretches on two-lane highways in southern peninsular Malaysia as shown in Figure 1 was considered in this study. This criterion was set to obtain the required traffic data along with the rainfall data. The observed sites were best representative of rural two-lane highways on free-flow facility at passing and no-passing zones wherein the traffic ensures a high proportion of impeded vehicles.

The experimental design and analysis include careful site selection to incorporate the isolated effects of wet weather on drivers' behaviour, improved spatial compatibility of traffic and weather datasets, identification of vehicles in car-following state, development of the empirical car-following models, and implication of the model on CRI over the range of the speed during dry and wet weather to evaluate the drivers' perception of risks during various traffics and highway conditions. Furthermore, all sites were carefully selected far enough from traffic light and junctions to allow vehicles attaining the desired speeds prior to their reaching the traffic recorder device. The study sites were free from any roadway defects, vertical as well as sharp horizontal curvatures because such factors could have affected the drivers' speed control and desired headway selection.

An automatic traffic counter (ATC) with a couple of pneumatic tubes was installed at both study areas. It was used to count and record data 24 h at four sites. However, only daytime data from 7.00 am to 7.00 pm was used for the analysis to ensure that recorded traffic data are appropriate to evaluate the required traffic parameters within the range of traffic flows. Rainfall data were acquired from Malaysia's Department of Irrigation and Drainage (DID) based on information of rain gauge station located within 2 km from the site. This distance considered ensures the spatial compatibility of traffic parameters and weather relationship. DID provide rainfall data (in mm) in 5 minutes interval and rainfall rate (in mm/h) can be calculated.

The required rainfall data is only the rainfall incidence in 5 minutes intervals regardless of its intensity to study drivers' perception of risk in car-following behaviour during rainfall (wet weather) compared to no rainfall (dry weather). Average vehicles speeds and distance headway are the most important parameter for addressing drivers' car-following behaviour [34]. From the traffics data acquired using ATC, the speed, headway, volume, and classification of individual vehicle were obtained. Distance headway was then calculated from the fundamental speed, time and distance relationship.

For identification of vehicles under car following, this study adopted the same approach described by Puan [9]. Time headway threshold below or equals to 5s was used for identification during car-following scenario. For each individual vehicle, the traffic data, roadway characteristics (passing and no-passing zones) data and weather (dry and wet weather) data were matched to produce four groups of data sets. For each group of data set vehicle classification, following headway (time and distance), and speed were determined. Vehicles were classified as either car or heavy good vehicles (HGV) to produce four sets of following classes (car-car, car-HGV, HGV-HGV and HGV-car). Spot speed data for impeded vehicles have been grouped to speed class. The speed class width was evaluated to obtain practical sample frequencies for every speed class. For each vehicle following types and each speed class, distance headway, time gap and CRI data belonging to it were assembled into distance headway, time gap and CRI classes, respectively.

In order to calculate distance headway and CRI in accordance with speed class and vehicle following class categories for two types of roadway conditions depending on two types of weather, all data were transferred to CSV files and R codes were developed. A median (hence taken as mean) was obtained for the following distance, time gap (TG) and CRI correlation. The median headway, TG and CRI in every speed class were utilized instead of the arithmetic mean to avoid the biased explanation of data. Distance headway, H was estimated using equation (2).

$$H_{distance} = v\,t \tag{2}$$

where $H_{distance}$ is the distance headway, v is the speed of the following vehicle and t is the time headway between the following and the leading vehicle.

However, CRI has stronger impact during accident. Thus, the vehicle's (speed × weight) is used as proxy measure to determine the accident severity. Mathematically, CRI is as expressed in equation (3). Therefore, the values of CRI are measured and counted during car-following for two cases (normal and wet) conditions to calculate relative CRI, $CRI_{Relative}$ as shown in equation (4). $CRI_{Relative}$ is explored to observe and evaluate any trends of the perceived accident severity in the range of the speed during car-following behaviour.

$$CRI = V * W/TG \tag{3}$$

where V and W are speed and weight of the following vehicle.

$$CRI_{Relative} = CRI_{Wet}/CRI_{Normal} \tag{4}$$

It is important to mention that the data on the weight of moving vehicles are not often indicated on traffic manuals or police report, thus poses difficulty towards CRI evaluation. The weight-in-motion sensors technology is commonly used to get the data on vehicles' weight. However, such technologies

are expensive and need to be installed under the pavement. The weight of an object is determined by its size and material density, where it can be assumed that all vehicles have same width, height and density. Consequently, vehicle's weight is related to the variation of its length. Thus, the vehicle's (wheel base) can be used as proxy measure to determine the vehicle's mass. The present study suggested that vehicle's wheel base is directly linked to its length and thus, can be used in calculating CRI as showed in equation (5). However, relative CRI has been calculated using equation (4) for each speed class and vehicles following class. Meanwhile, speed-CRI relation is developed to correlate speed class and relative CRI for each car-following class in car following behaviour. Speed-CRI relationship determines the perception of accident severity during car-following in the range of the speed.

$$CRI = V * WB/TG \tag{5}$$

where V is speed (m/s), WB is wheel base (m)of the following vehicle and TG is the time gap (s).

5. Result and discussion

5.1. Speed data

Data on more than 200,000 vehicles (mix of free flowing and restrained vehicles) were counted at 4 locations. Table 1 presents the number of restrained and impeded vehicles gathered from both passing and no-passing zones during both dry and wet weather circumstances. For every vehicle, the driving speed, driving direction, vehicle class, and the passing time were recorded. Only vehicles with time headways of less than 5s were considered in the assessment. Speed distribution of the impeded vehicles was analysed to illustrate the relationship between speed class and frequencies. Speed distribution of impeded vehicle (Car following car) during dry and wet weather for both passing and no passing zones were plotted in figure 2. Chi-square test was used to examine the probability distribution of the impeded vehicles' speeds. The speed distribution frequency is not significantly different from the lognormal distribution ($p>0.05$) at passing and no-passing zones during both dry and wet weather. At passing zone, χ^2 values are 27 and 36, and p-values are 0.30 and 0.29, for dry and wet weather respectively, when compared with standard lognormal distribution. While at no-passing zone, χ^2 values are 27 and 36, and p values are 0.30 and 0.27, for dry and wet weather respectively, when compared with standard lognormal distribution. The distribution also reveals that most of the impeded vehicles had travelled at relatively low speeds (less than 60 km/h). However, wet weather situations were generally more related with the spread in the speed distribution than that of dry one.

Table 1. Number of impeded vehicles captured during dry and wet weather from all sites.

Site description	Vehicle number (Dry weather)	Vehicle number (Wet weather)
Free flow with passing zones	30401	25196
Free flow with no passing zones	20468	18244
Total vehicle number	50869	43440

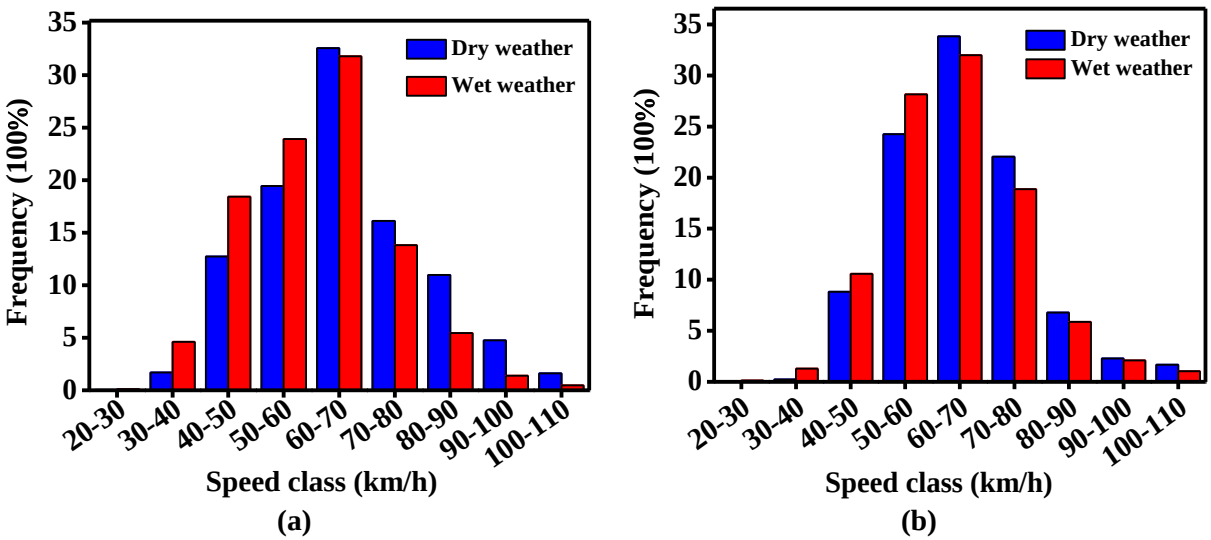


Figure 2. Speed distribution of (car following car) during dry and wet weather conditions for (a) passing zone and (b) No-Passing Zone.

5.2. Distance headway

The headway analysis considers the distribution of impeded vehicles separation by assuming that successive vehicles tried to maintain a minimum safe distance between them. Knowledge on the frequency of distance headway distribution determines the collective reaction and the interaction of drivers based on their perception for maintaining the safe following distance. In this evaluation, the distance headway data were assigned to the speed class for every vehicle following types. Then, the headway data belonging to each speed class was clubbed to headway class. Figure 3 depicts the distance headway distribution of car following car pattern for the speed class (50-60 km/h) for both passing and no passing zones. Chi-square test was conducted to examine the probability distribution. The histogram of distance headway distribution frequency followed the lognormal distribution during both dry (χ^2 = 147; p = 0.33) and wet (χ^2 = 168; p = 0.32) weather at passing zone. Distance headway distribution was also found to follow lognormal distribution at no-passing zone during both dry (χ^2 = 168; p = 0.32) and wet (χ^2 = 169; p = 0.30) weather.

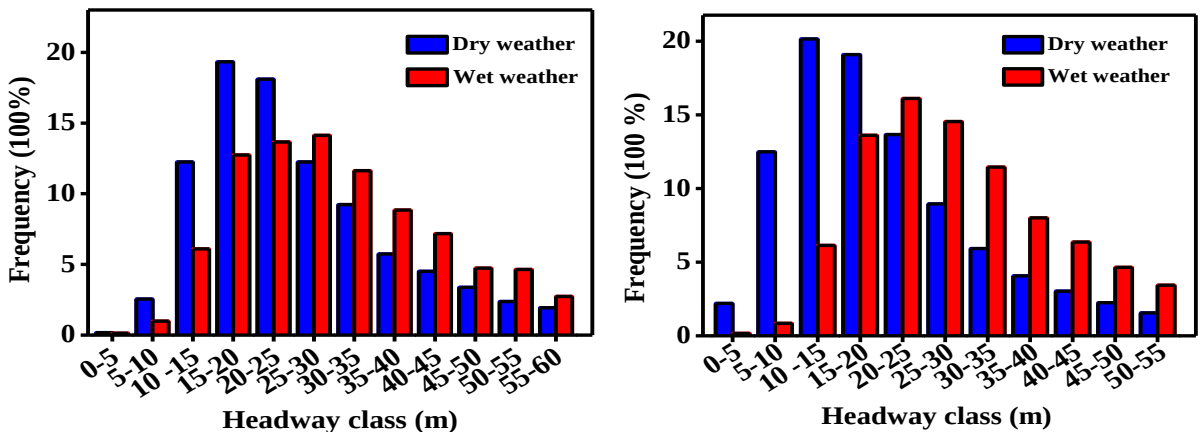
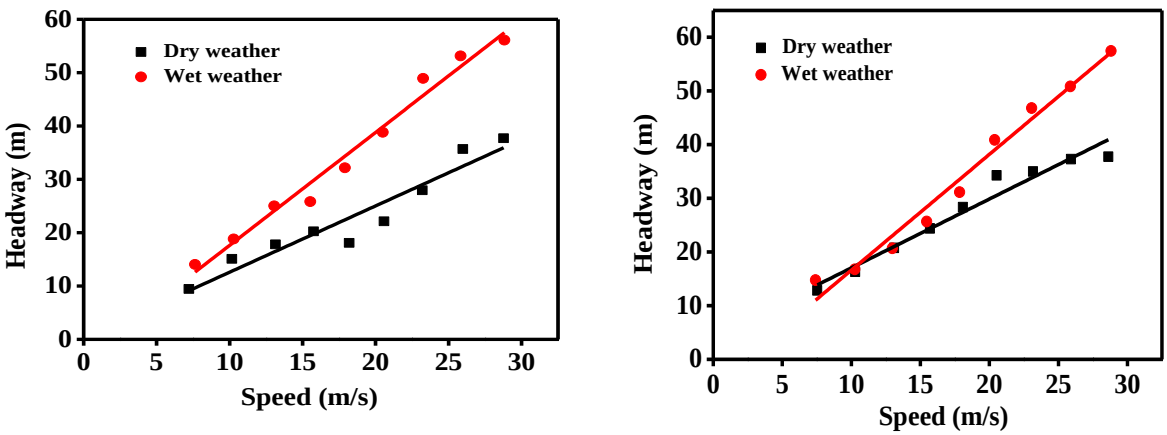


Figure 3. Headway class distributions of all vehicles during dry and wet weather condition for (a) passing zone and (b) no-passing zone.

5.3. Development of car-following behaviour models

To develop the empirical model based on statistical analysis, present study follows the regression techniques for each dataset that represents different weather conditions, highway features, and vehicles following type. The functional relationship of the restrained vehicles speed and their following distance based on median speed and headway values in the corresponding speed class were developed to determine the car-following models. This approach is similar to the one adopted earlier by Puan [9]. Figure 4 demonstrates the developed models for car following car category at passing and no-passing zones during dry and wet weather. The positive relationship between headway and speed indicates that the driver could maintain longer distance headway to leading vehicle with increase in the speed. Tables 2 and 3 summarize the outcome of the regression relations for all vehicles' following categories at passing and no-passing zone, respectively.

The high values of R^2 during dry weather ranging from 0.86 to 0.98 and wet weather ranging from 0.94 to 0.98 for both passing and no-passing zones clearly indicate a strong correlation between vehicle's headway and speed. Moreover, the shift of the regression line above the wet weather curve signifies that all the drivers tried to maintain longer distance headways irrespective of the speed, vehicle type and highway characteristics. This is obvious because of the drivers' awareness of the long stopping distance caused by the wet pavement. However, speed and distance headways choice are based on the drivers' individual differences in evaluating the risk and its compensation with adequate headway distance. Moreover, the drivers risk perception during wet weather is still not clear within the range of the speed.



(a) (b)

Figure 4. Relationship between speed and following distance for car following car on (a) passing zone and (b) no-passing zone.

Table 2. Regression results for each type of following vehicles at passing zone.

Following type	Sample size	$H = A_0 + A_1V$		
		A_0	A_1	R2
All vehicle (Dry)	30401	0.17	1.24	0.92
All vehicle (Wet)	25196	-3.55	2.12	0.97
Car-Car (Dry)	15098	-0.91	1.24	0.97
Car-Car (Wet)	15478	-5.80	2.26	0.98
Car-HGV (Dry)	11313	6.10	1.07	0.97
Car-HGV (Wet)	7526	0.54	2.01	0.98
HGV-HGV (Dry)	2661	9.23	1.16	0.86
HGV-HGV (Wet)	662	1.84	2.34	0.96
HGV-Car (Dry)	1329	3.62	1.20	0.97
HGV-Car (Wet)	1530	-8.73	2.75	0.98

5.4. Implication of the model on CRI

Current investigation proposes the implication of the empirical models of car-following behaviour on chosen risk index (CRI) to evaluate drivers' perception of accident severity. Speed data of impeded vehicles was grouped during dry and wet weather to speed classes and vehicles following type. For each vehicle following types and speed class, CRI was calculated based on vehicle speed, vehicle length and time gap. The relationship between driving speed and CRI during car-following was calculated for dry and wet weather to identify the relative CRI. Normal CRI has been calculated for dry weather for all speed classes and for all vehicle following classes as normal situation. Data acquired at normal condition (dry) served as reference to compare with wet weather condition.

Relative CRI was used as an indicator of risk consequence (severity) to depict the deviation of CRI values when the normal condition changed to wet weather. A low value of relative CRI indicates higher drivers' adjustment to the perceived accident risk which implies a safe driving behaviour. Table 4 presents the calculated CRI (normal, wet and relative) for speed classes for different car-following categories.

Table 3. Regression results for each type of following vehicles at no-passing zone.

Following type	Sample size	$H = A_0 + A_1V$		
		A_0	A_1	R2
All vehicle (Dry)	20468	4.20	1.28	0.95
All vehicle (Wet)	18244	-4.97	2.16	0.97
Car-Car (Dry)	15145	1.13	1.33	0.96
Car-Car (Wet)	15979	-3.52	2.16	0.97
Car-HVG (Dry)	4216	5.39	1.23	0.96
Car-HVG (Wet)	1527	2.57	1.95	0.98
HVG-HVG (Dry)	685	3.73	1.73	0.86
HVG-HVG (Wet)	208	1.42	2.43	0.94
HVG-Car (Dry)	422	0.43	1.73	0.98
HVG-Car (Wet)	530	-5.77	2.65	0.95

Table 4. CRI values for speed classes and different car-following categories.

Speed class (km/h)	Speed (km/h)	Speed (m/s)	CRL (normal)	CRL (wet)	CRL (relative)
20-30	26.60	7.39	18.71	13.99	0.75
30-40	36.65	10.18	27.76	22.77	0.82
40-50	47.12	13.09	40.43	29.31	0.72
50-60	56.77	15.77	50.56	35.45	0.7
60-70	65.56	18.21	49.34	38.21	0.77
70-80	74.09	20.58	49.11	42.91	0.87
80-90	83.56	23.21	52.13	49.15	0.94
90-100	93.49	25.97	51.21	49.31	0.96
100-110	103.61	28.78	56.22	55.53	0.99

For all the speed and vehicle following classes, CRI values tend to decrease during wet weather compared to the dry weather (normal situation). This reduction in CRI value during wet weather resulted from the driver's adoption of low speeds and greater time gaps. Relative CRI for speed classes and vehicle following classes were presented to illustrate speed-CRI relationship for all vehicles following classes (Figures 5 and 6). The determination of lower CRI and related speed permitted continuous

assessment and evaluation of the perceived risk as well as safe driving behaviour. In the figures, Car-HGV indicates the highest CRI (unsafe driving behaviour) specifically at speed within the range of 23 m/s to 27 m/s for passing zone and at about 25 m/s for no-passing zone. Passing zone induced Car-Car drivers to attain lower CRI (safe driving behaviour) compared to no-passing zone at same speed of 15 m/s. Table 5 provides the comparison between passing and no-passing zones regarding the safe driving behaviour (lower values of CRI and the corresponding speeds) for all vehicles' following categories.

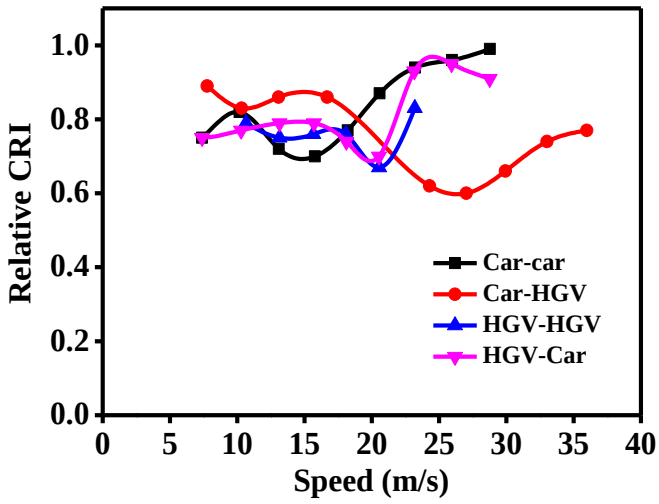


Figure 5. Chosen risk index during car-following in wet weather on passing zone.

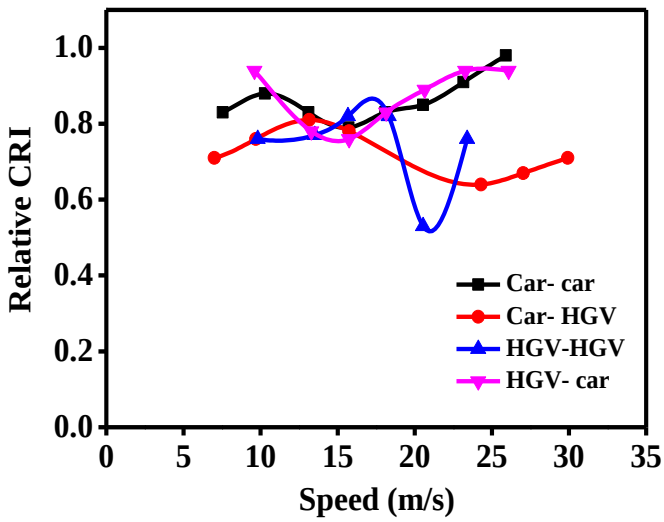


Figure 6. Chosen risk index during car-following in wet weather on no-passing zone.

Table 5. Summary of lower CRI values and corresponding speeds at passing and no-passing zones.

Vehicle following class	Passing zone		No-passing zone	
	Lower CRI	Corresponding speed (km/h)	Lower CRI	Corresponding speed (km/h)
Car following Car	0.7	56.8	0.79	56.5
Car following HGV	0.6	73.9	0.64	65.5
HGV following HGV	0.75	47.3	0.53	74.0
HGV following Car	0.7	73.9	0.76	56.7

6. Conclusion

Drivers' car-following behaviours during various traffic and weather conditions were analysed in detail. Empirical car-following models were developed to examine the effect of wet weather on drivers' perception of safe following distance. The implementations of the developed models on CRI allow the conceptualization and prediction of accident consequence via the interpretation of speed-CRI relationship in the range of speed during car-following behaviours. Such approach could assist on evaluation and comparison of traffic safety based on drivers' behaviour at various highway traffics. This comparison allows for exploring the effect of wet weather on accident consequence at passing and no-passing zones based on various vehicles following categories. Moreover, determination of lower CRI and related speed permitted continuous assessment and evaluation of the perceived risk as well as safe driving behaviour. The achieved CRI values indicate that, wet weather condition was accompanied with higher perception of accident consequences. The analysis revealed a slight difference in the CRI values during car-following behaviour between passing zone and no-passing zone. The analysis reveal that the less predicted accident severity occurs at the speed range of 47.3 to 73.9 km/h and 56.5 to 74.0 km/h i.e. which is associated with lower CRI values in the range of 0.60 to 0.75 and 0.53 to 0.79 at passing and no-passing zones, respectively. These findings are useful for traffic engineers and planners to accommodate traffic safety in roadway design.

Further works may consider matching the CRI with actual accident data to determine the prediction reliability for improved traffic management strategies and practice. Such comparisons may provide fundamental insight on how thoroughly the drivers under/overestimate the traffic risks. At specific speed, under estimation of the accident risk presented in high CRI, indicates the possibility of severe accidents incidence. While the over estimation of the risk presented in lower CRI may lead to the capacity drop (increased gap and decreased vehicle speed). These distinctions would certainly be useful to alleviate accident risk and to enhance traffic operations during adverse weather via implementation of traffic management strategies.

7. References

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