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Exploring Characteristics and Contributory Factors of Road Crashes and Near Misses Recorded via Dashboard Camera

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Abstract – *The use of dashboard camera (dashcam), or also known as digital video recorder (DVR) is increasingly becoming popular among personal vehicle owners nowadays due to affordable prices and higher video qualities. Many road-related incidents including vehicle crashes and near-misses can be recorded using dashboard cameras and shared via social media as lessons learned to others. Recorded videos of the incidents in real-time can be observed and used for a variety of purposes, including as supportive evidence for investigation. This paper explores the potential use of recorded dashcam videos in determining the characteristics and factors contributing to road crashes and near-misses under different situations. Selected video records of road crashes and near-misses were obtained from the internet thru social media and were used for analysis. The findings concluded that a dashboard camera is an effective digital video technology for traffic and accident monitoring systems. It has a high potential in providing supportive evidence of many frequently occurring factors and understanding the causes of road crashes and near-miss incidents.*

Keywords: Dashboard camera, video records, road crash, near-miss, contributing factors

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1.0 INTRODUCTION

Based on the road crash statistics by the Royal Malaysian Police, about 6,000 road fatalities were recorded each year in Malaysia. Moreover, approximately half a million road crashes occurred on Malaysian roads. Based on the mode of transport, motorcyclists contributed more than two-thirds of total road deaths, followed by occupants of passenger cars (RMP, 2019). The trend has been consistent for the past decades. Figure 1 shows the Malaysian road safety indices for the past 20 years (2000-2019). Although the data looks promising based on the

decreasing ratios, however, the target that is used in Malaysia as well as for the world is not on the ratio, but the exact fatality figures. If the number of recorded annual road fatalities is to be considered, around 18 people died each day on the Malaysian roads. This situation is worrying without people even realizing it.

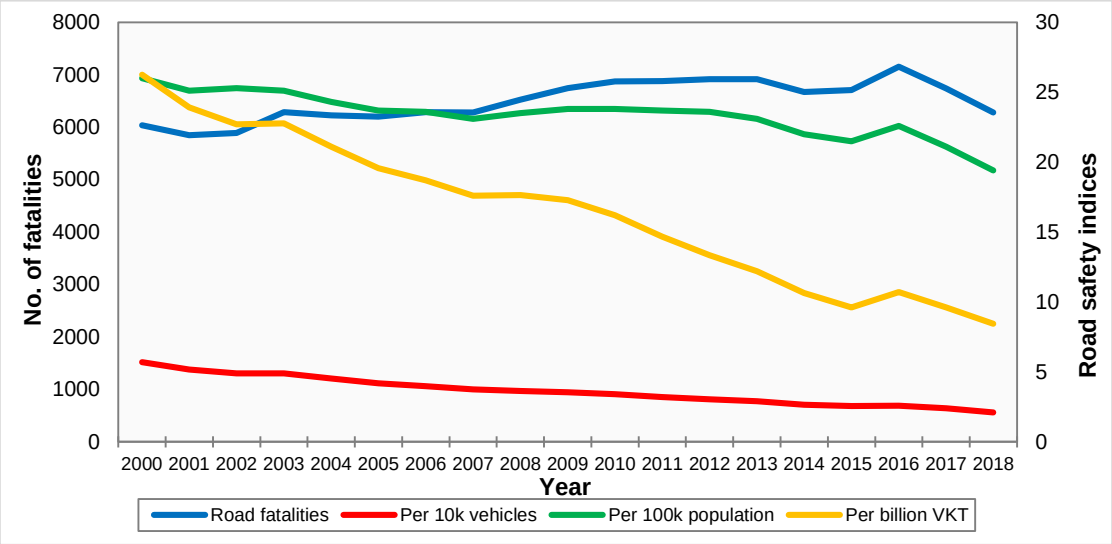


Figure 1: Malaysia' road fatalities and road safety indices

1.2 Near Miss Incident

Contrary to a road crash, a near miss is frequently regarded as an error. It is an unplanned event that has the potential to cause, but does not actually result in injury, property loss or vehicle damage. Limited studies have been carried out to determine or estimate the number of near miss incidents. Previous related studies mostly utilize data from self-reported surveys. Though the findings revealed the number as prevalent, the actual number of near miss could be higher as they usually go unreported. Some examples of near miss incidents are shown in Figure 2.

Figure 2: Examples of near miss incidents recorded by vehicle dashcam
(Source: Youtube, 2019a, 2019b)

1.3 Causes and Contributory Factors

In general, road crashes and near miss incidents occurred due to multiple factors, i.e., human (road user), vehicle and road environment. The unfortunate road-related events may occur due to one of the factors or a combination of multiple factors involving complex human interaction with the vehicle and/or road environment. Many studies concluded that the human factor is a major cause or contributor to the occurrence of road crashes (Rumar, 1985; Petridou & Moustaki, 2000; Dingus et al., 2016; Bucsuházy et al., 2020) with roughly 90% of the crashes

involved driver errors (Treat et al., 1977). Among examples of human-related factors include lack of incompetence and experience; carelessness and negligence (e.g., not using a turn signal when maneuvering a turn (Aqbal Hafeez et al., 2020)); inattention or distraction (e.g. using a mobile phone while driving or riding); and risky driving behavior.

1.4 Dashboard Camera

A dashboard camera is a recording camera that is usually mounted on the vehicle's dashboard or the vehicle's windscreen next to or replacing the rear-view mirror altogether as a new extension. The dashboard camera is also known as a dashcam, car digital video recorder (Car DVR), driving recorder, or an event data recorder (EDR). The basic nature of a dashboard camera is to act as a "silent witness" in the event of road accidents or mishaps as it is designed to carefully and accurately record every detail that takes place on the road in the span of the entirety of the vehicle journey, constraint only to the dashboard camera capacity. The onboard camera will continuously record the view of all escalating events on the road through either the windscreen, rear or other windows depending on the device placement during driving. Among others, the benefits are the usage provided first-hand evidence of a car accident. The usage also encourages discipline and safe driving etiquette among drivers and a vehicle equipped with a dashboard camera usually scores higher in risk assessment that translates to reduce insurance premiums.

1.5 Market Trend

Dashboard cameras are increasingly becoming popular with drivers across the globe. This is due to the more affordable price with higher quality videos which they can provide. In 2019, the global market size for dashboard cameras was valued at USD 2.8 billion with an estimated 36.1 million units of dashboard cameras sold. As shown in Figure 3, the dashboard camera demographic indicates that the usage and acceptance level is much higher in the Asia Pacific (AP) region compares to the rest of the world population. This distinction may very well be contributed by a few influences (Mordor Intelligence, 2021). The main two contributing factors can be identified as the laws and regulations aspect of dashboard camera and secondly the availability of options and cross-culture influences in a region.

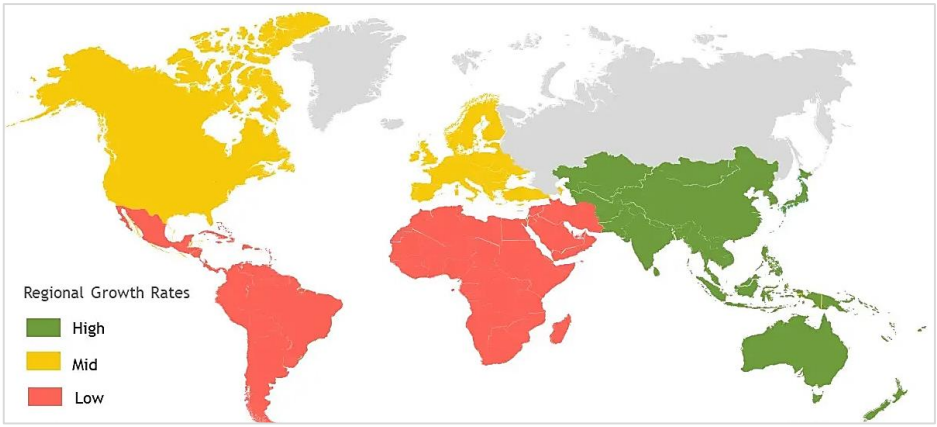
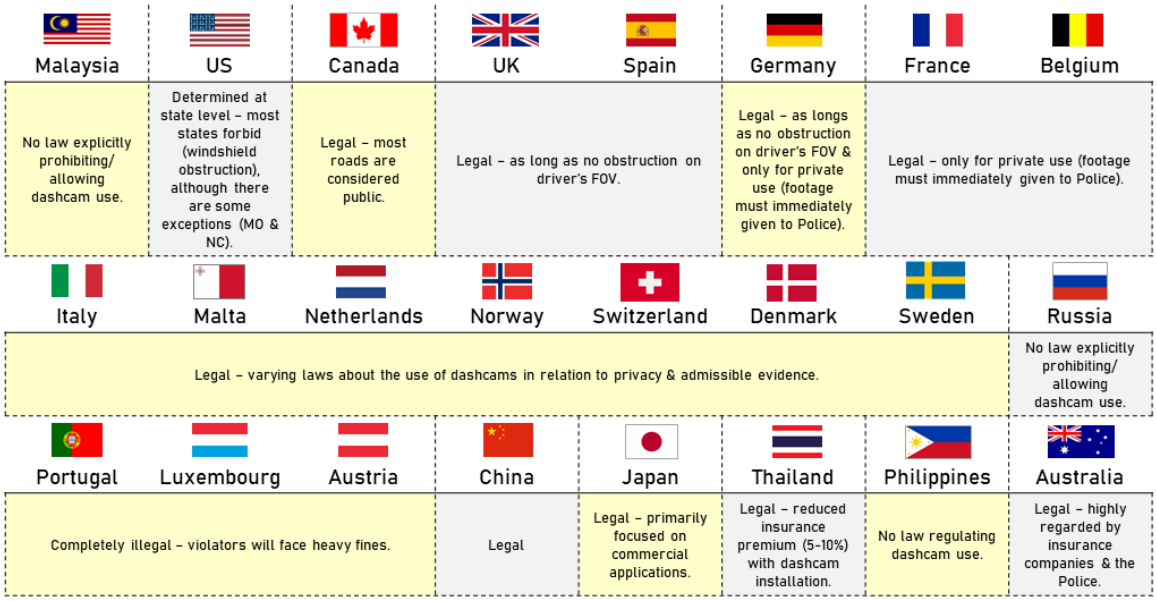


Figure 3: Dashboard camera market – growth rate by region (2020-2025)
(Source: www.mordorintelligence.com)

1.6 Dashcam Use Worldwide and Its Legality

Discussing the legal aspect of a dashboard camera is quite complicated as there are no acceptable and streamline laws that govern the use of dashboard cameras globally and when they do, it differs from one country to another. Figure 5 shows the overview of dashboard camera laws around the world. For countries with some sort of regulations in place to regulate the use of dashboard cameras, the level of acceptance is lower than those countries with unestablished laws and guidelines in managing the use of dashboard cameras. Even within a region with a set of control regulations in place, the disparity of user acceptance is extreme of the opposite end depending on government acceptance and initiatives in adopting the use of dashboard cameras starting with regulation, enforcement, encouragement, and public education. For countries without stipulated rules or unclear legislative procedures regarding the use of dashboard cameras, typically the acceptance level is above the global average level. As for Malaysia, there is still no law regulating the use of dashcams on the road.



Note: FOV – Field of view

Figure 5: Comparison of dashcam legality between countries
(Paultan, 2017; VIA Technologies, 2020; RAC Motoring Services, 2020; DashCamCar.com, 2020; Dash Cams Australia, 2020)

1.7 Study Importance and Objectives

In many road crashes, survived drivers or sometimes eyewitnesses may not fully explain what had happened prior to and during the crashes. Investigations are normally carried out on road crashes to determine the causes and contributory factors but are very limited on near misses due to unreported. Recorded videos from dashcam provide supportive evidence (a collection of facts and information that support initial evidence) that is lacking during the crash investigation process. Thus, this study is conducted to explore the potential use of dashcam video footage in determining: (1) the characteristics, and (2) contributory or causal factors; of recorded road crashes and near misses under different situations.

2.0 METHODOLOGY

2.1 Recorded Video Footage

Clear recorded video footage of near misses and road crashes that were readily available on the internet, specifically social media (Facebook), were used for this study. Most video footages were uploaded by members of the local dashcam, automotive and road safety-related group pages. To maintain confidentiality, no personal and other private information related to the uploaded video footage was recorded and used for analysis.

2.2 Data Analysis

Two stages of video analyses were sequentially carried out. A total of 178 uploaded video footages were randomly selected during the initial process (first stage video analysis). The selected video footages include those uploaded during the 3-month period from September to November 2020. During the first stage of video analysis, all required data that consist of the general incident, road and environment, and vehicle information were recorded by trained research assistants. Next, the reported incidents were examined, and unnecessary incidents were excluded during the second stage analysis. The unnecessary incidents include bad and dangerous riding or driving, road rage incidents, and traffic violations.

In total, 100 video footage were finally selected and categorized into road crash and near miss events for further analysis. Descriptive analysis was then carried out and a thorough review on the data and results obtained from the second stage analysis were done among crash investigation experts and fellow researchers. Most experts and researchers have vast experience (at least 10-year involvement) in conducting real-world, high-profile road crash investigations and reconstruction. Figure 6 summarizes the overall method used for data analysis.

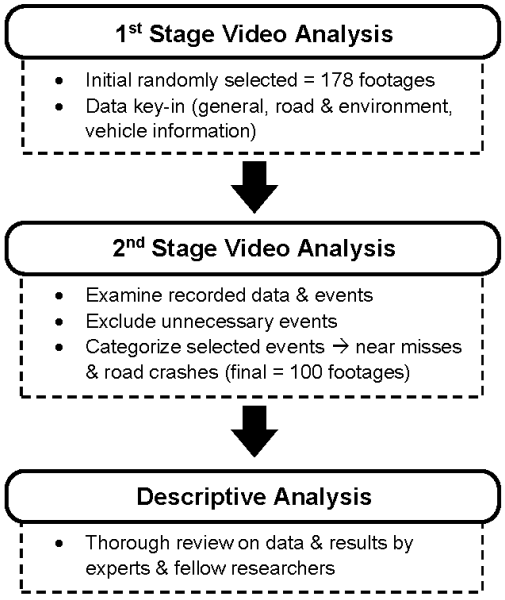


Figure 6: Data analysis process

3.0 RESULTS

3.1 Type of Incidents and Crash Configuration

As shown in Figure 7, the total number of incidents was 100 cases and from that, 24% were involved in road crashes and the remaining (76%) were near misses. Most road crashes were MVA or multiple vehicle crashes which involved two vehicles while two single-vehicle crashes (SVA) were recorded from the total road crashes. Figure 8 shows the percentage of road crash configuration. From the chart, side or angular impact was the most prominent among other types of road crash configuration with 12 road crashes were recorded. This is followed by rear impact with 5 road crashes, sideswipe (3 road crashes), and head-on impact and out-of-control with two road crash each.

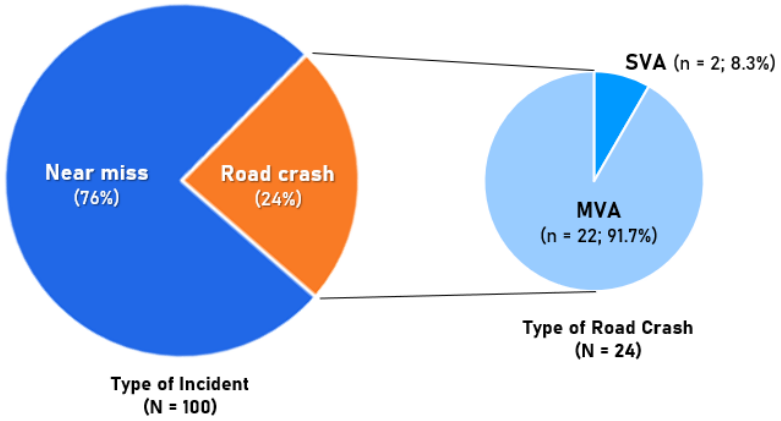


Figure 7: Type of incident and road crash

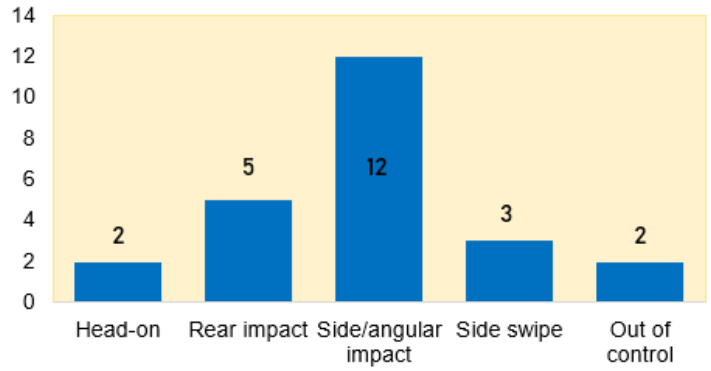


Figure 8: Road crash configuration (N = 24)

3.2 Type of Vehicles Involved

Out of 100 incidents, more than half, 58% involved dashcam-installed vehicles that recorded the incident. The remaining involved other vehicles that did not have any direct or indirect contact with the dashcam-installed-vehicles. In terms of the type of vehicles involved, the car was the highest with 55.0%, followed motorcycle (28.6%), and MPV and SUV around 12% (Table 1 tabulates the percentage of vehicle types according to different incidents (near miss and road crash). Based on the tabulated data, the car was the most prevalent in both near miss and road crash incidents with 108 and 27, respectively. Majority of the recorded incidents involved two vehicles.

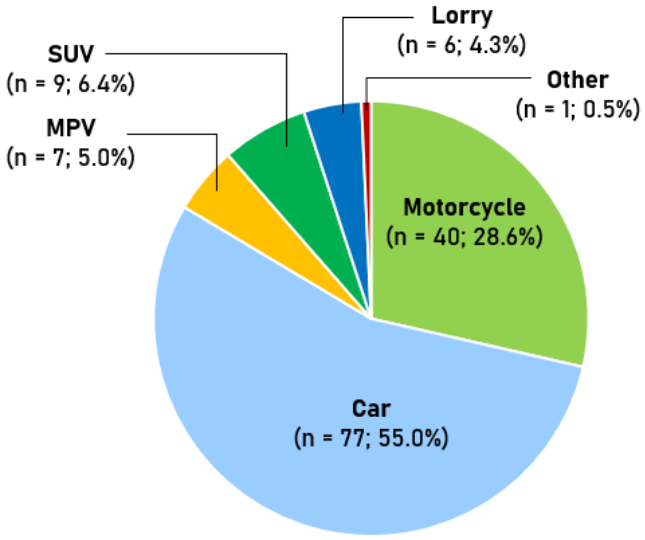


Figure 9: Type of vehicles involved (N = 140)

Table 1: Type of vehicle based on incident category

Type of Vehicle	Near miss	Road Crash
Motorcycle	25	15
Car	51	26
MPV	6	1
SUV	7	2
Lorry/Trailer	4	2
Other	1	0
TOTAL	94	46

3.3 Lighting Condition and Weather

In terms of lighting conditions, most near misses and road crashes occurred during daylight (79.0%) (Figure 10). This is followed by night with a streetlight (16.0%). Only a few incidents took place at night at a location without streetlight condition (5.0%). The majority of the recorded incidents (overall at 97%) occurred during fine weather conditions. Table 2 shows the number of incidents concerning lighting conditions. The highest number of near miss incidents and road crashes occurred during daylight with the percentage of 82/9% and 66.7%, respectively. In terms of weather, the majority of the incidents occurred during fine days (98.7% of near miss incidents and 91.7% of road crashes) as highlighted in Table 3.

In most video footage, it was observed that the majority of the road incidents were clearly recorded by the installed dashcams. All the incidents that took place especially at night and in rainy conditions (despite the very low number of incident) could be clearly watched and analyzed. This highlights the excellent capability of currently available dashcams which are capable to record incidents in high-definition video quality.

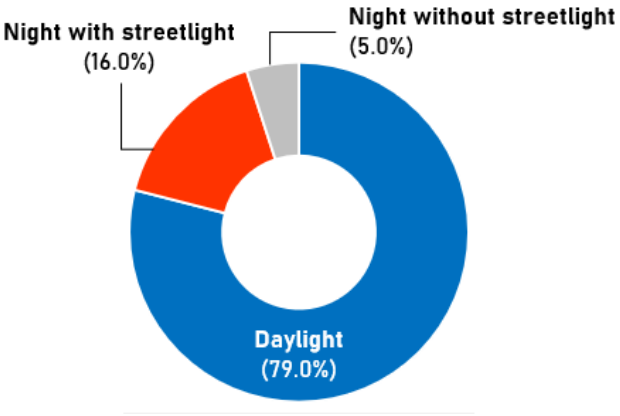


Figure 10: Lighting condition observed (N = 100)

Table 2: Lighting condition during near miss incident and road crash

Type of Vehicle	Near miss n (%)	Road Crash n (%)
Daylight	63 (82.9)	16 (66.7)
Night with streetlight	11 (14.5)	5 (20.8)
Night without streetlight	2 (2.6)	3 (12.5)
TOTAL	76	24

Table 3: Weather condition during near miss incident and road crash

Weather	Near miss n (%)	Road Crash n (%)
Raining	1 (1.3)	2 (8.3)
Fine	75 (98.7)	22 (91.7)
TOTAL	76	24

3.4 Location and Road Environment

The number of incident occurrences according to location and road environment are shown in Figure 11. Most incidents occurred in an urban area with 53%. The proportion is slightly equal for incidents that took place in suburban or rural areas with 47.0%. Equal percentages for both locations – urban and suburban/rural areas (12 cases for each location area) – were recorded for road crashes (Table 4). In terms of the road environment, the residential area recorded the highest occurrence for overall incidents, followed by shop lot or business area (Table 5). But, if we look into the separate incident, most recorded near misses occurred in the residential area (395%) while most road crashes took place at shop lots or business areas (41.7%).

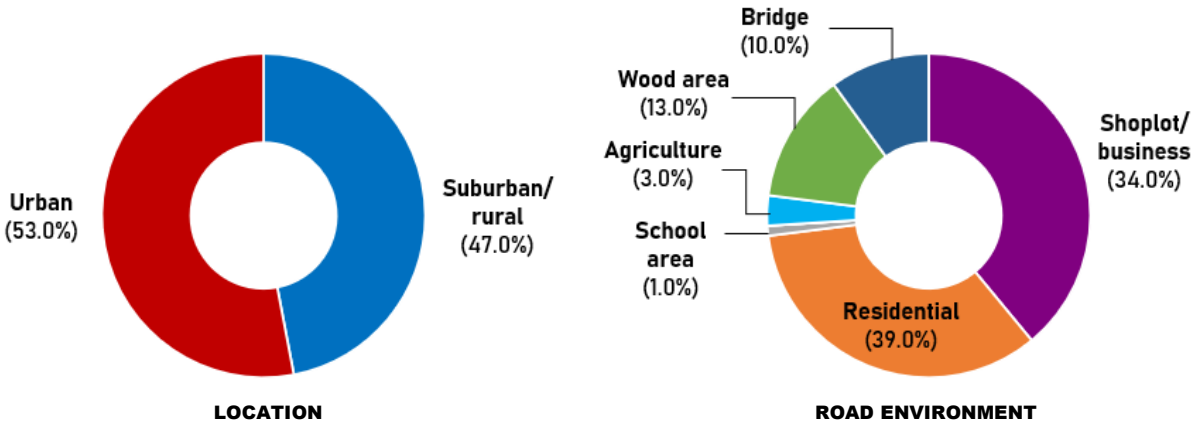


Figure 11: Location (left) and road environment (right)

3.5 Traffic Condition

The traffic condition for this study was divided into three categories: low, medium, and high. The categorization made was based on the traffic volume observed in the video footages at the time they were recorded. As highlighted in Figure 12, the majority of the near miss and road crash events occurred during medium traffic conditions. Low traffic conditions recorded the second-highest occurrence for both events, while only a few events, less than one-tenth, occurred during high traffic conditions, for instance during traffic congestion.

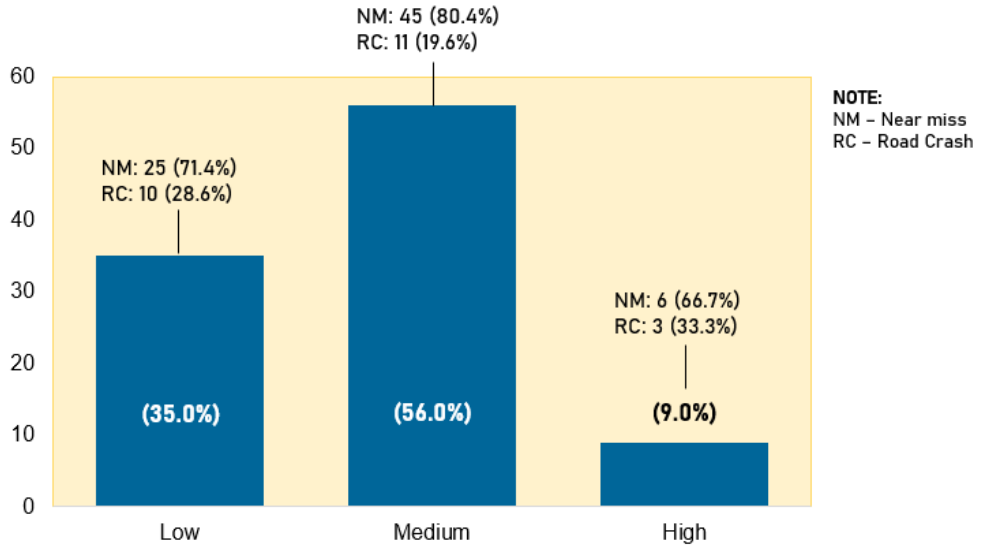


Figure 12: Traffic condition during incident occurrence

3.6 Causation and Contributory Factors

Both road environment and human factors were managed to be identified as the causation to the occurrence of the recorded incidents. As for road and environment factor (Figure 13), others (inadequate sight distance, road hazard, and work zone management) was identified as the most prevalent, followed by improper merging or exit lane. In terms of the human factor (Figure 14), risky riding or driving was identified in many recorded incidents. This behavior includes inattentive riding or driving, neglecting turn signal either during a lane change or turning

maneuver, red-light running, as well as ride or drive against traffic in the opposite direction. Approximately 13% of the overall incidents were caused by the combination of both factors – road environment and human. Nevertheless, evidence of vehicle contributory factors such as brake or component defect, could not be established. Proper on-site vehicle inspection is necessary to establish such evidence related to vehicle defects.

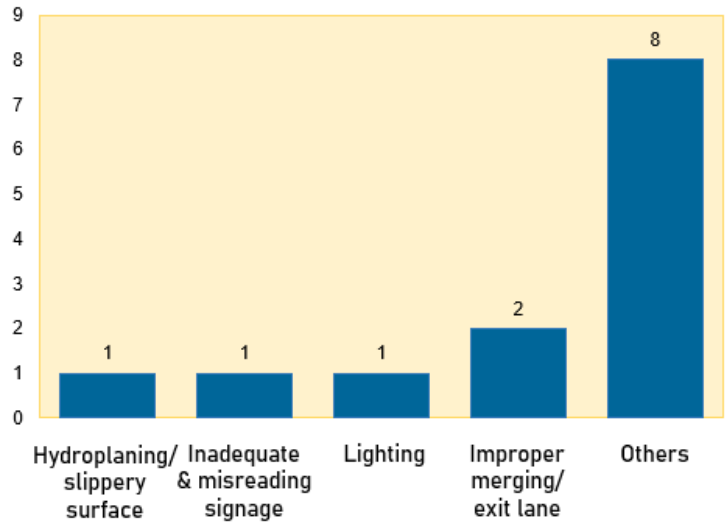


Figure 13: Road and environment factor

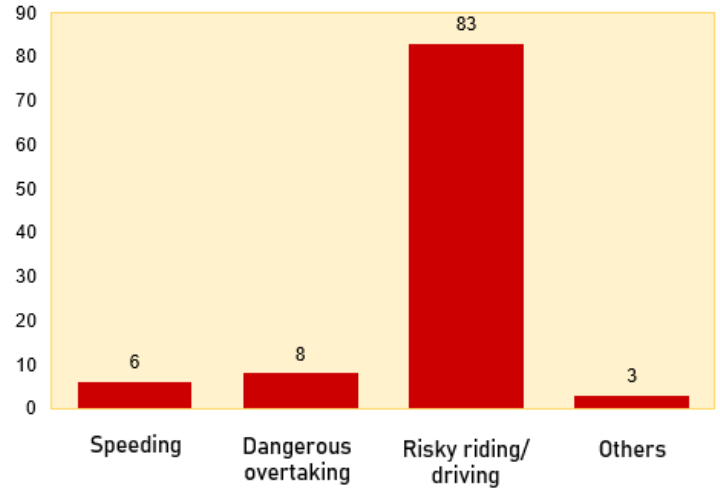
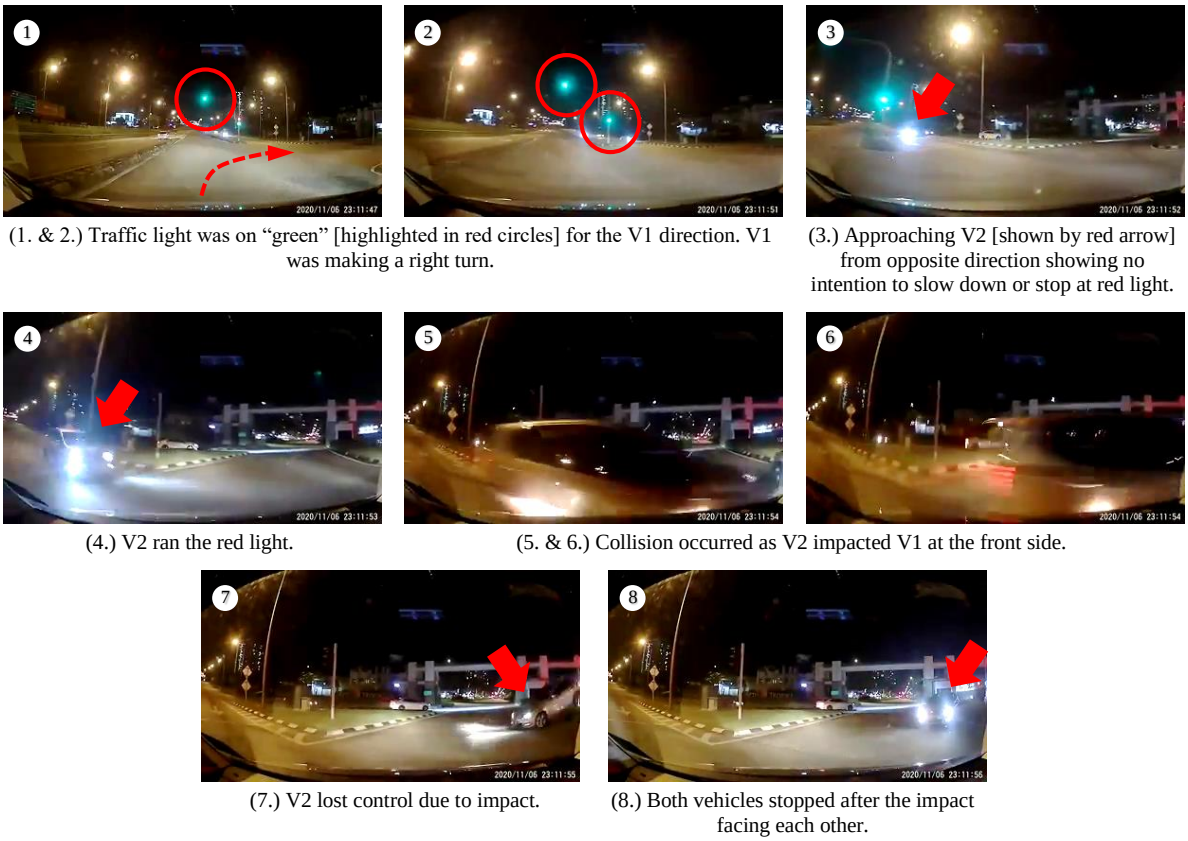


Figure 14: Human factor

3.7 Case Studies

3.7.1 Case Study 1 – Road crash

This case study is a road crash involving two vehicles from different directions at a signalized intersection. The crash occurred at night with streetlight conditions. As observed from the video footage in Figure 15, the vehicle with a dashcam installed (V1) was impacted by another vehicle (V2) that was traveling from the opposite direction. Based on the video footage, the approaching V2 in the opposite direction did not slow down upon reaching the intersection. It ran the red light despite seeing the V1 was about to make a turn. This road crash was clearly caused by the risky driving behavior performed by the V2's driver.



(1. & 2.) Traffic light was on "green" [highlighted in red circles] for the V1 direction. V1 was making a right turn.

(3.) Approaching V2 [shown by red arrow] from opposite direction showing no intention to slow down or stop at red light.

(4.) V2 ran the red light.

(5. & 6.) Collision occurred as V2 impacted V1 at the front side.

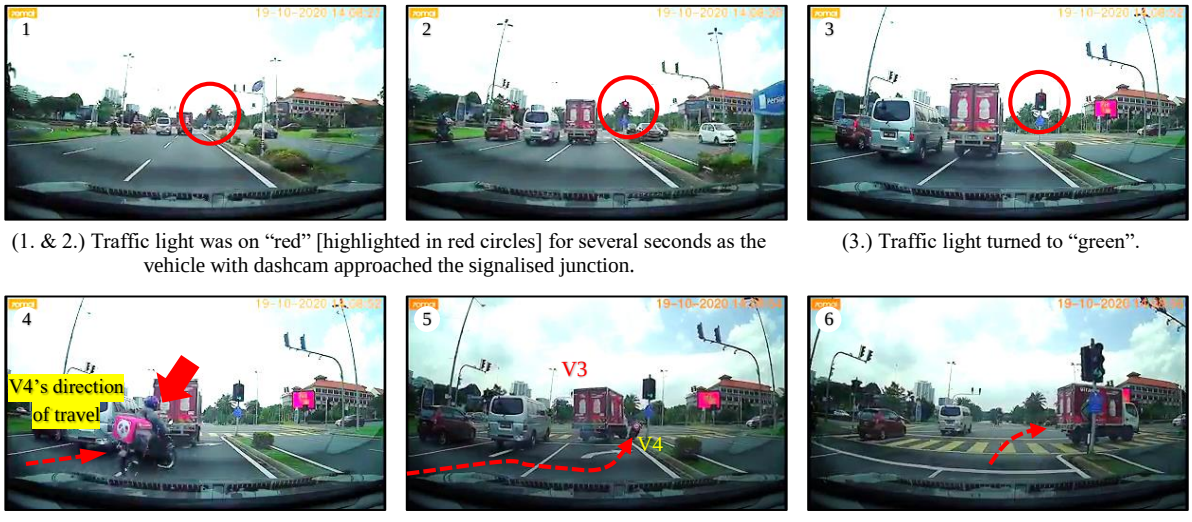
(7.) V2 lost control due to impact.

(8.) Both vehicles stopped after the impact facing each other.

Figure 15: An illustration depicting the sequence of Case Study 1's road crash (Ekzos.my, 2020)

3.7.2 Case Study 2 – Near miss

The second case study is a near miss incident that took place at signalized junction. The incident occurred during daylight. It involved a lorry (V3) which was about to make a U-turn and an e-hailing motorcycle (V4).



(1. & 2.) Traffic light was on "red" [highlighted in red circles] for several seconds as the vehicle with dashcam approached the signalised junction.

(3.) Traffic light turned to "green".

(4.) An e-hailing motorcycle (V4) [shown by red arrow] suddenly approached from behind as the lorry (V3) started to move.

(5.) V4 weaved in between V3 (about to make a U-turn) and the traffic light post leading to near miss incident.

(6.) V4 managed to pass through the V3 which was negotiating a U-turn.

Figure 16: An illustration depicting the sequence of Case Study 2's near miss incident (Dashcam Malaysia Komuniti DashCam, 2020)

As the V3 was about to turn, it almost collided with a sudden approaching V4 from the rear direction of the V3. Despite the high-risk situation, the V4 managed to weave through tight space in between the V3 and traffic light post (Figure 16). From this footage, it is obvious that the motorcyclist (V4) was involved in risky riding behavior that led to the near miss incident. The motorcyclist did not yield to the signaled lorry upon reaching the signalized intersection.

4.0 DISCUSSION

Many previous studies had examined the use of video cameras and video recorders, either fixed or mobile, to monitor traffic as well as record any incident that occurs throughout a certain observed period. From the recordings, much useful information can be gathered. In the case of a road incident, visual-based information related to vehicle type, location, traffic condition, time, weather, and occurrences prior to and during the incident can be extracted. Consequently, possible contributory factors can be determined by analyzing the recorded video footage. A study by Witchyangkoon and Sirimontree (2016) explored the use of a dashboard camera as an effective traffic monitoring system. The findings revealed that real-time road accident occurrences can be observed from the recorded images. The images can be enhanced using digital image processing technology so that more valuable information can be extracted. Other studies had investigated the use of CCTV or video surveillance through video cameras for managing and monitoring vehicle traffic, as well as for investigating the road-related incident (Conche & Tight, 2006; Kurdi, 2014). Conche and Tight (2006) assessed the potential use of CCTV images in investigating and understanding the causes of road crashes in urban areas in Leeds, United Kingdom. The study concluded that CCTV is highly potential in providing supportive evidence to assist in road crash investigation and determination of crash causation.

This study has managed to explore the characteristics and contributory factors of road crashes and near misses in various situations, from video footages recorded by dashcams. With the high capability of current dashcams available on market, dashcams can provide useful information related to the investigated road incidents. In this case, the process of investigating the incidents occurred especially at night and raining condition can be easily done by analyzing the video footages. This is most probably due to the capability of the dashcams to record high-quality video images. Some video footages were also recorded with sound from the vehicle occupants and surrounding. However, several pieces of information are unavailable that can only be obtained thru actual on-site investigation. This unavailable information includes impact speed, the injury sustained by the road crash victims, vehicle and component defects (if related), and road deficiencies. The study revealed the human factor as a prevalent contributory factor in most recorded incidents. The findings are aligned with other studies that investigated the contributory factors in many road crashes (Treat et al., 1977; Rumar, 1985; Afiqah et al., 2020) and near miss incidents (Neale et al., 2005; Uchida et al., 2010), in which human-related factor was found as the most identified occurrence factor, besides road and environment, and vehicle.

5.0 CONCLUSION AND RECOMMENDATIONS

Based on the findings, it is concluded that the human factor (risky riding or driving, dangerous overtaking, and speeding) was prevalent in the majority of the recorded incidents. Overall, dashcams have a high potential for providing supportive evidence through their recorded video footage. With dashcam video footages, at full HD and 4K quality, it is possible to extract visual-

based information such as traffic conditions, types, and driving characteristics of vehicles, as well as the occurrences of before and during the near miss or road crash. According to the trend and owing to the rise in sales of new vehicles, the industry is expected to witness an increase in the demand for the installation of such cameras in commercial and private vehicles.

As mentioned earlier, this study was carried out in a short period of time. Due to the time constraint, only a low number of video footages were used for analysis. Thus, it is suggested to increase the number of video footages to obtain more data for analysis. It is also to be noted that injury and vehicle damage information could not be determined in this study. The way forward for future study is to combine with actual in-depth crash investigation data that would give a more comprehensive result. Finally, other than using dashcam video records, a fixed-location study, such as utilizing CCTV recorded videos, could be carried out to explore contributory factors of road crashes for improvement of certain locations.

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The authors would like to express their appreciation to all those who were either directly or indirectly involved in the success of this study and the completion of this paper.

LIMITATION

It is to be noted that the samples (video footages) used in this study do not represent most of the road incidents that occurred on Malaysian roads. In addition, only video footage that was uploaded during the short period of three months was selected. Hence, the findings should be interpreted with care and be perceived as an initial exploration of the characteristics and contributory factors of road crashes and near misses recorded via a dashboard camera that took place on Malaysian roads.

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