ORIGINAL ARTICLE

Work-related Road Traffic Crashes in Malaysia: A Comparison between Fatal and Temporary Injury Cases

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ABSTRACT

Introduction: Work-related road traffic crashes have significant implications for both employers and employees, leading to devastating consequences such as fatalities, injuries, and property damage. Despite the increasing focus on road safety research, little attention has been given to identifying factors associated with work-related road crashes. This paper explores and compares the characteristics of fatal cases (FOT) with the characteristics of temporary injury cases (HUS) in work-related road traffic crashes. **Materials and methods:** Seven years of work-related road crash claim compensation data between 2014 and 2020 was obtained from the Social Security Organization (SOCSO). A total of 546 cases were involved, including 56 FOT and 490 HUS cases. Categorical data analysis techniques were employed to examine the distinctions between FOT and HUS cases. **Results:** The results indicate a lower representation of transportation sectors in FOT cases, with the corresponding odds approximately 84% lower. Conversely, small and middle enterprises exhibit an odds ratio of about 5.1 times higher in FOT compared to HUS cases. **Conclusion:** The findings from this study can serve as proactive measures for employers in addressing work-related road traffic crashes. This includes enhancing road safety awareness programs specifically focusing on groups engaged in nighttime shifts and those involved in sending and pickup duties. Considering the distinct risk profiles of large enterprises versus small and medium enterprises, future studies are necessary to clarify the effectiveness of the road safety initiatives undertaken by both types of enterprises.
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INTRODUCTION

Road traffic crashes have been identified as one of the main contributors to deaths around the world. The World Health Organization (WHO) reported that approximately 1.3 million people lose their lives every year due to road traffic crashes (1). In addition, low- and middle-income countries contribute to more than 90% of fatalities related to road traffic crashes. Malaysia is one of the middle-income countries that also recorded a higher number of road fatalities. For example, in the year 2021, a total of 4,539 people died due to road traffic crashes in the whole of Malaysia (2). This number places Malaysia as the second country to record a higher fatality after Thailand in Southeast Asia. Even though there are many initiatives taken by the relevant authorities in Malaysia to reduce road traffic crashes, there is room for improvement in road safety.

People who work in the road transportation sector are among the risk groups due to high exposure on the road. The issue of road traffic crashes involving workers also became a concern worldwide. For example, among the total number of work-related deaths in the US, Australia, and the EU, at least one-quarter to over one-third were caused by work-related motor vehicle crashes (3). A more specific study reveals that the transport, postal, and warehouse sectors are one of the three main sectors contributing to higher work-related fatalities in Australia, with 49 fatalities recorded in the year 2020 (4). A statistic published on Consumer News and Business Channel (CNBC) Make It reveals that out of the total work-related deaths in the US, 1,778 workers (37.3%) were attributed to the transportation sector (5). Approximately one-third of fatal workplace injuries result from road traffic crashes in the province of British Columbia, with an annual average of 20 deaths per year between 2017 and 2018

(6). In addition, this report also reveals that 1,400 people got injuries and leave of work due to work-related traffic crashes. A study conducted in Italy reported that about 128,795 cases of work-related road traffic crashes were reported from 2014 to 2018 (7).

In Malaysia, there were also higher recorded percentages of road traffic crashes related to work. The Social Security Organization (SOCSO) revealed that work-related road traffic crashes increased by 83% in the year 2019 compared to the year 2009 in Malaysia (8). Furthermore, compared to industrial accidents, work-related road traffic crashes have contributed to almost three times the number of fatalities over the past decade. A study conducted by Oxley et al. (9) also discovered that two-thirds of reported work-related fatal and severe injury incidents are road traffic crashes. Work-related accidents not only cause loss of life and property but also the sources in the development of the nation. In the year 2020, the SOCSO compensated about RM150 million to relatives or workers who got involved in work-related road crashes (10). This fund could be allocated towards human resource development, contingent on the successful reduction of work-related road crashes in the future.

Numerous prior studies have examined the attributes of work-related road traffic crashes worldwide. The working environment stands out as a major concern in this matter. Research conducted in Australia discovered that factors such as time constraints related to work and the influence of colleagues collectively played a significant role in compromising individuals' capacity to drive safely, thereby contributing to a higher occurrence of vehicle crashes (11). They also disclosed that drivers indicated mental stress, whether arising from their job or personal situations, negatively impacts their driving performance. Many companies established road safety management to manage road safety in the companies and conveyed it to employees. However, when it comes to implementation, certain deficiencies are evident. For example, there was a lack of clarity in most organizations regarding who was liable or accountable for road safety management. A study conducted in Australia involved 83 managers from diverse small, medium, and large organizations, with varying degrees of risk management maturity across organizations, demonstrating how workplace driver safety is insufficiently integrated with the Occupational Safety and Health organizational. This is with particular emphasis on the following areas: accountability, journey management, vehicle procurement and maintenance, licensing and driving history, recruitment and induction, driver behavior and training, incident reporting and investigation, and infringement management (12). Another study conducted in Australia revealed that numerous organizations are falling short of effectively managing driver behaviors and addressing the risks associated with road safety in a systematic manner (13). They discovered that there was a lack of comprehensive policy, consistent and sufficient detail in relation to crash data reporting and recording, and a lack of communication and promotion strategies associated with promoting safe work-related driving.

Drivers' demographic also plays a vital role in work-related road traffic crashes. Oxley et al. conducted an analysis of commuters using a motorcycle in Malaysia and discovered that traffic injuries vary by age (9). The findings revealed that riders 65 years and above were more likely to be fatal or obtain serious injuries when involved in traffic crashes compared to riders aged 15 – 24 years. This finding is in line with previous research conducted in New South Wales, Australia, which discovered that work-related road crashes become more critical as the population ages and older adults continue to drive and work until a later age (14). In addition, driver performance in terms of visual search ability, reaction time, speed estimation, and handling skills is mainly influenced by driver age (15). Another important demographic factor that is related to work-related road traffic crashes is gender. A study in Spain analyzed 724,596 occupational traffic crashes from 2009 to 2019. It was revealed that males were more likely to be involved in fatal crashes (16). Another study conducted in Brazil, which analyzed reported cases of work-related road traffic crashes in 21 Road Traffic Accident Information Sentinel Units in Pernambuco revealed that more than 87% of victims are male (17). In Malaysia, a study utilizing data from the Workers Environment Health Unit from 2014 to 2016 and focusing on healthcare workers indicated a higher likelihood of injuries and fatalities among males in comparison to females (18).

Previous research has also highlighted the significant role of temporal factors in work-related road traffic crashes. A study in the US discovered that work-related traffic fatalities are more likely to occur during the workweek as opposed to the weekend and also tend to happen more frequently during daytime hours rather than nighttime (19). Another study focusing on work-related cases in West Virginia, US, reveals that more than 60% of work-related road traffic crashes occur during daytime (20). Meanwhile, Robb et al. (21) conducted a systematic review investigating risk factors for work-related road traffic crashes and injuries and discovered that the night shift is one of the contributing factors to this type of crash. In Malaysia (22), due to limited study design and available data, the relationship between road traffic crashes and post-call or post-night shifts among healthcare workers in government hospitals cannot be concluded.

Insufficient information concerning road geometries and conditions is also a contributing factor to the escalation of work-related road traffic crashes. A study in the Republic of Korea (23) investigated the human factors and injury severities among delivery truck

drivers and discovered that driving on the expressway and straight road segments increases the probability of being involved in traffic crashes and severe injuries. Furthermore, a comparison between work-related and non-work-related studies conducted in West Virginia, US (20) discovered that work-related crashes more frequently occur on the highways, curve sections, and on a grade. They conclude that the topography and road system are the underlying factors behind these crashes, particularly considering that a significant portion of West Virginia's terrain consists of mountainous regions characterized by narrow, steep, and curved roads. Drivers unfamiliar with those road conditions might be involved in single-vehicle crashes (24). In Italy, a study (7) using compensation for occupational injuries data from 2014 to 2018 discovered that work-related road traffic crashes mostly occur along straight sections and followed by crossroads.

Previous road safety research has identified wet road surfaces as a contributing factor to road traffic crashes. Wet road surface is often associated with rainy conditions. For example, a study conducted in sub-urban areas in Pakistan (25) discovered that road traffic crashes increased significantly during rainy seasons. Liu et al. (26) evaluate the vehicle braking performance on wet pavement surfaces. They discovered that breaking distance increases when the speed of a vehicle and rain density increase. However, there were also contrasting findings observed. For example, research in China indicated that bad weather encourages drivers to adopt a more careful approach, causing them to decrease their driving speed and ensure a safer following distance from other vehicles (27). A case study in Wyoming, US (28) revealed that both dry and road surfaces were positively associated with both total and equivalent property damage-only crashes. Interestingly, Budzyński et al. (29) reveal that the risk of traffic crashes is low for precipitation only but higher for wet road surfaces without precipitation. In the case of work-related road traffic crashes, the same debate also occurs. For example, large truck rollover crashes along mountainous roads in Wyoming are less likely to happen on icy or wet road surfaces (30). In contrast, research in Australia discovered that wet weather is among the factors that increase crashes involving prime movers and rigid trucks (31). In terms of injuries in work-related crashes, a study conducted in China revealed that production equipment operators and transport workers exhibited an elevated risk of injury on rainy days (32).

In most cases, work-related traffic crashes involve different types of vehicles for work purposes, from the biggest trucks to small vehicles such as motorcycles or bicycles. A study in Italy reveals that more than 50% of work-related traffic crashes between the years 2014 and 2018 involved private cars, followed by motorcycles (25.9%) and heavy vehicles (9.5%) (7). In the UK, analysis of police report data from the years 1996 – 2004 exhibited that the highest group of vehicle types involved in work-related road traffic crashes is large goods vehicles, followed by van/pickup and company cars (33). In Australia, prime movers (predominantly tabletop trailers) overrepresent the type of vehicles involved in work-related road traffic crashes between 1989 and 1992 (31). This group was then followed by cars and vans, wagons, and four-wheel drives as second and third places, respectively. These findings demonstrate that the types of vehicles involved in work-related road traffic crashes vary across different countries.

While previous studies have identified risk factors for work-related crashes, little attention has been given to the specific context of Malaysia. This study addresses this gap by focusing on Malaysian work-related crash data, using compensation cases from SOCSO. By comparing fatal (FOT) and temporary injury (HUS) cases within the Malaysian context, this study will provide locally relevant insights into the unique risk factors and patterns contributing to different crash severities. This knowledge can be directly applied to develop culturally and context-appropriate intervention programs for Malaysian workplaces, significantly improving road safety for workers.

MATERIALS AND METHODS

Data collection

The Malaysian Royal Police employ the POL27 form for documenting information concerning road traffic crashes within Malaysia. It is a legal requirement for individuals involved in road traffic crashes to file a police report within 24 hours, particularly when seeking to make an insurance claim (34). In Malaysia, numerous companies provide accident insurance coverage. However, for employers operating a business or company within the country, it is obligatory to obtain insurance for their employees through SOCSO. This obligation is explicitly outlined in the Employees' Social Security Act 1969 (Act 4), stipulated by Malaysian law. In general, the SOCSO categories claim compensation cases into two categories: 1) Dependents' Benefits (FOT) and 2) Temporary Disablement Benefit (HUS). Compensation data from SOCSO's system were extracted to an Excel file and subsequently verified with the Malaysian Royal Police database to augment information about road traffic crashes. Following this, a data cleaning process will be implemented, wherein only records containing all attributes will be retained for further analysis. It is essential to highlight that this study focuses on examining cases that occurred between 2014 and 2020, including reports from the year 2021. However, the data extraction process for the analysis concluded on 31st March 2021, and any cases reported after this date will not be included in the analysis.

In this study, the age of victims was divided into two

categories: young (< 31 years old) and older (≥ 31 years old). The classification is established by the Youth Societies and Youth Development Act (Amendment) 2019 (Act 668), which designates individuals aged between 15 and 30 as youth (35). This study also categorizes the type of organizations into four categories, including manufacturing, transportation, services, and others. Manufacturing categories are organizations involving production industries, including factories, while transportation categories are organizations that conduct delivery, transporting, and storage services. The services group was categorized as an organization that provides finance, insurance, real estate, business, public services, and statutory authorities. Meanwhile, mining, quarrying, construction, agriculture, forestry, fishing, trading, retail trades, hotels, and restaurants are the organization types grouped into other types of organizations. In Malaysia, the definition of Small and Medium Enterprises (SMEs) depends on two circumstances. For the manufacturing sector, SMEs are characterized by businesses with a sales turnover not exceeding RM50 million or a workforce of no more than 200 full-time employees. In the services and other sectors, SMEs are businesses with a sales turnover that does not surpass RM20 million or a workforce of fewer than 75 full-time employees.

In the early months of 2020, the global COVID-19 pandemic prompted many countries to implement movement control orders in an effort to mitigate the spread of the virus including Malaysia. This situation had a profound impact on various sectors, leading to a widespread transition to remote work. Essential services, however, were exempted and continued conventional on-site operations. To assess the impact of the pandemic, we conducted a comparative analysis between the years before and during the outbreak, specifically focusing on the FOT and HUS cases. The results revealed no significant differences across these two periods (p-value = 0.245). Additionally, this analysis also confirmed that the compensation claims remained relatively consistent between these periods. Figure 1 illustrates the trend of FOT and HUS cases from 2014 to 2020. Both FOT and HUS cases show an increasing trend from 2014 to 2016, reaching their peak in 2016 with corresponding percentages of 26.8% and 29.2%, respectively. However, there is a significant drop in the percentages of both FOT and HUS cases in 2017, with corresponding percentages of 7.1% and 11.6%, respectively. This trend fluctuates until 2020. The variable associated with weather was excluded from the list of analyzed variables due to the limited observations (1.5%) during rainy and foggy conditions.

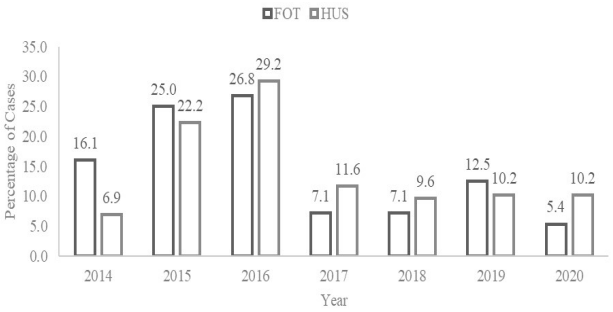

Figure 1: Percentage of FOT and HUS Cases from 2014 to 2020. FOT - fatal cases, HUS - temporary injury cases

Data analysis

This study utilizes disaggregate analysis techniques to investigate variations in road traffic crashes between cases involving FOT and HUS. The analysis involves two distinct outcome variables: 1) the frequency of crashes and 2) the proportion of crashes. The proposed technique was employed to test several explanatory variables, encompassing demographic attributes of victims, temporal factors (time and day), road and environmental conditions, vehicle crash specifics, and factors related to the purpose of travel. Contingency tables were utilized to execute a sequence of chi-square tests, facilitating a comparison of statistical distinctions between FOT and HUS cases across the range of explanatory variables. Furthermore, odds ratios were calculated, which furnish a relative indication of event occurrence likelihood within a specific category relative to other categories. This was done to gauge the effect size and the intensity of the association between pairs of categorical variables.

Ethical clearance

This study received approval from the Ethics Committee for Research Involving Human Subjects at Universiti Putra Malaysia under reference number JKEUPM-2021-690.

RESULTS

Following the data cleaning process, a comprehensive analysis was conducted on a total of 546 cases, which comprised 56 cases of FOT and 490 cases of HUS. Table I represents a univariate analysis comparing the demographic characteristics of victims involved in FOT and HUS cases. It is revealed that about 61% of FOT cases in work-related road traffic crashes involved older victims (age ≥ 31 years old). However, the univariate analysis identified no significant difference in the age of victims for FOT and HUS cases *($p = 0.590$)*. In terms of ethnicity, this study only compare Malay with other

types of ethnicities due to the higher number of victims among Malay involved in FOT and HUS. It is revealed that compared to other ethnicities, the odds of Malay involvement in HUS were 1.8 times higher *(95% CI 1.04 – 3.46)* than in FOT cases. The analysis also indicates that the number of victims is largely similar between occupational and non-occupational drivers and riders with 26 cases (46.4%) and 30 cases (53.6%) for FOT and 268 (54.7%) and 222 (45.3%) for HUS, respectively. Similar to the findings in the age category, no significant difference was observed between occupational and non-occupational drivers or riders in terms of occupation *(p=0.240)*.

Table I: Demographic characteristics

Variable	FOT	HUS	OR (95% CI)	c^2, p-value
Age				
< 31*	22(39.3)	211 (43.1)	1.00	-
≥ 31	34(60.7)	279(26.9)	1.17 (0.66–2.06)	0.29, p = 0.590
Ethnicity				
Others*	18 (32.1)	98 (20.0)	1.00	-
Malay	38 (67.9)	392 (80.0)	0.52 (0.29–0.96)	4.43, p = 0.035
Occupation				
Non-occupational driver/rider*	26 (46.4)	268 (54.7)	1.00	-
Occupational driver/rider	30 (53.6)	222 (45.3)	1.39 (0.80–2.43)	1.38, p = 0.240
Types of Organization				
Others*	26 (46.4)	135 (27.6)	1.00	-
Services	22 (39.3)	233 (47.6)	0.49 (0.26–0.90)	5.45, p = 0.019
Transportation	3 (5.4)	97 (19.8)	0.16 (0.05–0.55)	10.8, p <0.001
Manufacturing	5 (8.9)	25 (5.1)	1.03 (0.36–2.96)	1.05, p = 0.350
Size of Organization				
Large Enterprise*	12 (21.4)	285 (58.2)	1.00	-
Small Middle Enterprise (SME)	44 (78.6)	205 (41.8)	5.09 (2.63–9.89)	27.34, p <0.001

**reference category*

Regarding the type of organization, the majority of FOT cases, approximately 46.4% (26 cases), were reported in other types of organizations. It is followed by the services sector with 22 cases (39.3%). The transportation and manufacturing sectors only recorded 3 (5.4%) and 5 (8.9%) claimed cases, respectively. On the other hand, services sectors recorded higher HUS cases compared to others, about 233 (47.6%). The sector that recorded lower HUS cases is manufacturing about 25 cases (5.1%). Compared to other types of organizations, transportation sectors were less represented in FOT cases, with the corresponding odds about 84% lower *(OR0.16, 95%CI 0.05 – 0.55)*. Services sectors were also less represented for FOT cases, with the corresponding odds about 51% lower *(OR0.49, 95%CI 0.26 – 0.90)*. However, manufacturing sectors were discovered to be not significantly different in FOT and HUS cases *(p =0.350)*. In this analysis, it was determined that SMEs were disproportionately represented in FOT cases, accounting for 78.6% of all instances within this category. Compared to large enterprises, the odds of FOT cases for SMEs were about 5.09 times higher *(95% CI 2.63 – 9.89)* than HUS cases.

Table II presents the distribution of FOT and HUS cases by time of the day, day of the week, and peak hours. About 58.9% and 87.6% of FOT and HUS cases, respectively, occur during the daytime. However, nighttime was overrepresented in FOT cases, with the corresponding odds about 4.90 times *(95% CI 2.70 - 8.90)* higher than in HUS cases. The highest FOT and HUS were recorded during weekdays, with the corresponding percentage being 87.5% and 83.5%, respectively. However, the odds ratio analysis confirms no significant differences between weekdays and weekends *(p > 0.05)*. In terms of peak and non-peak hours, the highest recorded cases for both FOT and HUS are during non-peak hours. Odds ratio analysis also determined no statistical differences between FOT and HUS cases between peak and non-peak hours.

Table II: Characteristics of the incident by time of the day, day of the week, and peak hours

Variable	FOT	HUS	OR (95% CI)	c^2, p-value
Time of day				
Day time*	33 (58.9)	429 (87.6)	1.00	-
Nighttime	23 (41.1)	61 (12.4)	4.90 (2.70–8.90)	31.63, p < 0.001
Day of week				
Weekdays*	49 (87.5)	409 (83.5)	1.00	-
Weekend	7 (12.5)	81 (16.5)	0.72 (0.32–1.65)	0.60, p = 0.439
Peak Hours				
Peak Hours*	7 (12.5)	80 (16.3)	1.00	-
Non-peak Hours	49 (87.5)	410 (83.7)	0.73 (0.32–1.67)	0.55, p = 0.458

**reference category*

Malaysia is officially divided into 13 states and three federal territories. Due to the fewer FOT cases in every state, the univariate analysis only compares FOT and HUS between two groups: others and Kuala Lumpur and Selangor. Referring to Table III, the odds of FOT cases in Kuala Lumpur and Selangor are lower compared to other states and HUS cases *(OR0.13 95%CI 0.06 – 0.26)*. In terms of road type, most FOT and HUS cases happen on the non-expressways, with the corresponding percentage

respectively 85.7% and 76.5%. Nevertheless, there is no significant difference discovered between FOT and HUS cases in non-expressways and expressways.

Straight road segments were overrepresented in FOT cases, with the most significant occurrence compared to other types of road geometries. Straight segments exhibited FOT and HUS incidents at rates of 59.3% and 48.6%, respectively. Due to limited observations, the univariate analysis compared straight segments with other types of road geometries (refer to Table III), revealing no significant difference between other road geometries and straight segments.

Table III: Road and Environmental Factors

Variable	FOT	HUS	OR (95% CI)	c^2, p-value
Crash Zone				
Others*	47 (83.9)	195 (39.8)	1.00	-
Kuala Lumpur and Selangor	9 (16.1)	295 (60.2)	0.13 (0.06–0.26)	39.67, p < 0.001
Road Type				
Non-Expressways*	48 (85.7)	375 (76.5)	1.00	-
Expressways	8 (14.3)	115 (23.5)	0.54 (0.25– 1.18)	2.43, p = 0.119
Road Geometry				
Others*	24 (40.7)	252 (51.4)	1.00	-
Straight	35 (59.3)	238 (48.6)	1.54 (0.89–2.67)	2.43, p = 0.119

**reference category*

The distribution of FOT and HUS cases across vehicle types is presented in Figure 2. For both FOT and HUS cases, motorcycles represented most of the cases, with corresponding percentages of 41.1% and 78.4%, respectively. Cars and lorries were overrepresented in FOT cases, representing about 23.2% and 21.4%, respectively. Due to the higher number of cases involving motorcycles, univariate analysis was conducted to compare this type of vehicle with others and presented in Table IV. It shows that motorcycles were less represented in FOT cases, with the corresponding odds about 81% lower *(OR0.19, 95%CI 0.11 – 0.34)*.

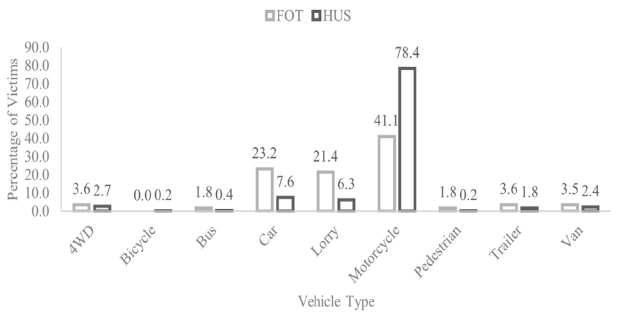

Figure 2: Percentage of Victims by Vehicle Type for FOT and HUS. FOT - fatal cases, HUS - temporary injury cases

Table IV: Vehicle, Crash, and Travel Factors

Variable	FOT	HUS	OR (95% CI)	c^2, p-value
Type of vehicle				
Others*	33 (58.9)	106 (21.6)	1.00	-
Motorcycle	23 (41.1)	384 (78.4)	0.19 (0.11–0.34)	36.84, p < 0.001
Crash Type				
Multi-vehicle*	27 (48.2)	315 (64.3)	1.00	-
Single vehicle	29 (51.8)	175 (35.7)	1.93 (1.11–3.37)	5.55, p = 0.018
Collision Type				
Others*	36 (64.3)	325 (66.3)	1.00	-
Out-of-Control	20 (35.7)	165 (33.7)	1.09 (0.61–1.95)	0.09, p = 0.764
Travel Purpose				
Others*	23 (41.1)	347 (70.8)	1.00	-
Sending/picking up food/documents/ money/ cheques/item	33 (58.9)	143 (29.2)	3.48 (1.97–6.14)	20.36, p < 0.001

**reference category*

Figure 3 illustrates the collision types observed in both FOT and HUS cases. A total of seven distinct categories of road traffic collisions were identified, including crushed, head-on, hitting animal/object/ pedestrian, 'out-of-control', overturned, rear impact, side impact, and others. 'Out-of-control' recorded the higher number of cases for both FOT and HUS, with the corresponding percentages of 35.7% and 33.7%, respectively. Due to a limited number of observations for other types of collisions, the univariate analysis only compared 'out-of-control' collisions with other types of collisions. This analysis revealed that there is no significant difference between FOT and HUS cases in terms of 'out-of-control' collisions compared to other types of collisions. Additionally, when comparing single and multi-vehicle crashes, the analysis found that the odds of single-vehicle crashes being involved in FOT cases were approximately 1.93 times higher *(95% CI 1.11 – 3.37)* than in multi-vehicle crashes *(p = 0.018)*.

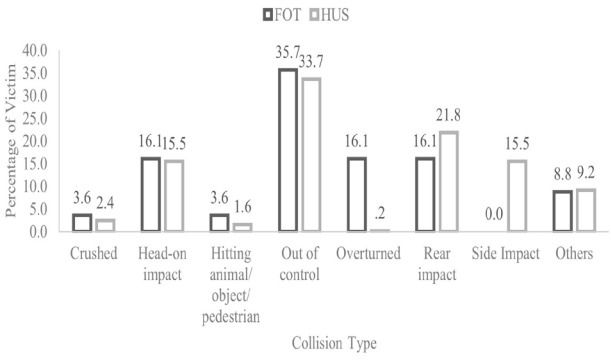

Figure 3: Percentage of Victims by Collision Type for FOT and HUS. FOT - fatal cases, HUS - temporary injury cases

Work-related road usage can involve various purposes, such as attending outside events, buying company needs, providing services to clients or customers, driving company staff, picking up company vehicles, making deliveries, transporting goods, or any other job-related travel. Univariate analysis determined that tasks involving sending or pickup duties were approximately 3.48 times *(95% CI 1.97 – 6.14)* more likely to be associated with FOT cases compared to other tasks, with a statistically significant p-value of less than 0.001.

DISCUSSION

The annual road traffic crashes continue to rise and have been identified as one of the main contributors to global fatalities. Individuals employed in the transportation sector face heightened exposure to road traffic crashes. Statistics reveal that fatalities resulting from road traffic crashes among workers are threefold higher compared to accidents reported within industrial areas. Despite the growing emphasis on road safety research, there has been a notable lack of attention dedicated to identifying factors associated with work-related road crashes. Therefore, this study aims to examine the characteristics of FOT and compare this with the characteristics of HUS in work-related road traffic crashes.. Discussions will be organized to delve into disparities in demographic characteristics, temporal aspects, road and environmental conditions, as well as vehicle-related factors, crash-related attributes, and factors pertaining to travel purposes.

Demographic Characteristics

The analysis from this study indicates that there are no differences in age among crash victims between FOT and HUS cases. This finding aligns with the results of prior research conducted by Sultana et al. (35). Their investigation revealed that young workers did not face a higher risk when compared to older workers. Conversely, a study conducted in Australia discovered that drivers aged 65 years and older exhibited an almost twofold increased likelihood of experiencing permanent injuries or fatalities due to work-related crashes when compared to the younger age group (14). Their conclusion highlights that frailty and pre-existing health conditions are factors that are more likely to amplify the severity of injuries sustained by older drivers when they are involved in traffic crashes.

Malaysia is a country characterized by its diverse range of ethnicities. Compared to other ethnic groups, it has been observed that Malays are more likely to be involved in FOT cases. This finding is contrary to the study conducted by Radzuan et al. (36), who discovered that young Malay drivers with more than five years of driving experience are more likely to be involved in fatal crashes. There are two explanations for this contradicting finding. First, in terms of population distribution, the Malay ethnic group constitutes the largest portion, accounting for 57.9% of the total population in Malaysia in the first quarter of 2023 (37). Indeed, this indicates that the Malay ethnic group experiences higher exposure factors in comparison to other ethnic groups. Second, in terms of risky driving/riding behaviors between ethnic groups. For example, Oxley et al. (9) revealed that Malay respondents were less likely to report wearing their helmets compared to other ethnic groups. Nevertheless, this finding also calls for deeper analysis and exploration within the literature, as there might be contrary evidence that needs to be considered.

This study discovered there is no significant difference between occupational and non-occupational drivers and riders. This result reveals that occupational drivers and riders demonstrate similar performance levels to non-occupational individuals despite the anticipated extra training provided by their employers. Research conducted in Australia revealed that numerous organizations struggle with effectively managing drivers' behaviors and addressing work-related road safety risks (13). Another study in Australia (12) has suggested that organizations should enhance driver competency by implementing effective workplace road safety programs. This approach is considered one of the viable alternatives to mitigate work-related road traffic accidents.

It has been identified that the services and transportation sectors contribute less to FOT cases compared to other types of organizations. Previous research conducted a survey among p-hailing riders in Malaysia indicates that riders with prior experience in the transportation sector were less likely to be involved in traffic crashes compared to riders who had previously worked in the food and groceries sector, as well as those without any prior work experience (38). As previously mentioned, a considerable number of organizations face challenges in effectively overseeing drivers' behaviors and tackling work-related road safety risks. This situation becomes even more pronounced for organizations that are not directly involved in the transportation sector, such as manufacturing.

As previously mentioned, this study classified organizations into two size categories: large enterprises and small and medium enterprises (SMEs). The analysis from this study reveals that SMEs are more likely to be involved in FOT cases compared to large enterprises. This might be due to the established road safety policy in the large enterprise compared to the SMEs. The previous research on occupational crashes among motorcyclists performing food delivery in the Republic of Korea discovered that 76.1% out of 1,317 injured couriers worked in small companies with less than five employees (39). Additionally, a study conducted in North Dakota and Colorado examined crash severity among commercial trucks between 2010 and 2016 (40). The findings indicated that small companies operating with a single truck had a higher likelihood of being involved

in traffic crashes. This was attributed to the increased frequency of shifts, leading to driver fatigue. Conversely, the study also revealed that when compared to small companies, larger companies were more prone to being engaged in crashes, resulting in multiple fatalities. This was attributed to the fact that larger companies often possess heavier and bulkier trucks that are challenging to maneuver. Additionally, these trucks require more time to execute emergency braking, contributing to the increased severity of crashes involving multiple fatalities.

Temporal Factors

It has been observed that the probability of being involved in FOT cases is higher when work-related crashes occur during nighttime. A similar finding was also reported by Chen et al. (41) when conducting an analysis of the risk factors affecting the severity of traffic crashes involving urban trucks in the Republic of Korea. They discovered that nighttime was among the factors contributing to the severity of truck crashes due to difficulty of vision. Driving during the night is also associated with drowsy (42). As an alternative, Chen et al. (41) suggested installing devices that can assist drivers, such as fatigue detection. In addition, most heavy vehicles travel during nighttime rather than daytime to avoid traffic congestion. This finding is contradictory to previous research that discovered work-related non-fatigue occurs during peak hours (43). This research was conducted in New South Wales, Australia, using workers compensation dataset between 1998 and 2002. They explain that this observation is mostly due to a higher number of commuting workers during peak hours.

Road and Environment Factors

This study compared Kuala Lumpur and Selangor with other locations concerning FOT and HUS cases and revealed that Kuala Lumpur and Selangor were less likely to contribute to FOT cases. This indicates that the Klang Valley, recognized as Malaysia's urban hub, is located within the federal territories of Kuala Lumpur and Putrajaya. It encompasses the surrounding cities and towns in the state of Selangor. An increase in traffic volume often correlates with a decrease in speeding behaviors, thereby reducing the potential for fatalities in the event of a traffic crash. The theory on the relationship between speed and traffic volume was established by Underwood in 1960 (44). This theory was further supported by a local study conducted by Abdul Manan et al. (45), who found that motorcyclists were more prone to violating the speed limit when passing through access points with low traffic volume on a particular stretch. Furthermore, a study on Spanish crosstown roads revealed that roads with low traffic volume tend to escalate the severity of driver injuries in the event of crashes, as opposed to roads with higher traffic volume (46). Another study utilizing road traffic crash data from England and Wales discovered that fatal crashes are more prone to occur in rural areas. This heightened risk could potentially stem from various factors, such as the unique characteristics of crashes in rural settings, the demographics of drivers in these areas, their habitual driving behaviors, or the increased challenges for post-crash response (47). On the other hand, this study also found that the type of road geometries does not affect the severity level of victims in work-related road traffic crashes. This discovery aligns with earlier research conducted by Mitchell et al. (31), which also revealed a similarity in the number of fatalities in single-vehicle crashes between curved and straight road segments.

Vehicle, Crash, and Travel Factors

Interestingly, even though the number of FOT and HUS cases is higher for motorcycles, the odds ratio demonstrates that this type of vehicle was less likely to be involved in FOT cases compared to HUS cases. This finding is contradictory compared to the characteristics of general crashes in Malaysia. For example, out of 3,568 fatalities due to road traffic crashes reported in the year 2021, 2,845 (79.7%) are motorcyclists (48). This could be attributed to the success of the awareness program carried out by relevant agencies in collaboration with employers, focusing on motorcyclists engaged in the transportation industry.

It was found single-vehicle crashes were more likely to contribute to FOT cases. Two factors may be contributing to this issue. Firstly, the prevalence of fatigue-driven driving among workers could significantly elevate the likelihood of run-off crashes. For example, a study analyzing data from the National Motor Vehicle Crash Causation Survey from 2005 to 2007 revealed that as much as 86.4% of run-off-road crashes were attributed to work-related stress or pressure (49). Second, heavy vehicles are also involved in run-off-crashes, which is one of the work-related road safeties. Heavy truck drivers typically operate their vehicles on interstate highways, where the risk of single-vehicle accidents, such as runoff-road incidents and rollovers, is elevated due to the high speeds involved.

The last factor that was found to increase the probability of being involved in FOT cases was sending and pickup duties. This finding could be attributed to several factors related to the nature of the work in the industry. Primarily, a significant portion of work in this sector involves delivery services, which inherently increases exposure to traffic. Additionally, time constraints during deliveries can amplify stress levels and contribute to an elevated risk of risky driving behaviors among drivers or riders, such as speeding and red light running. A study conducted by Christie et al. (50) identified that the emergence of gig couriers to fulfill the demand for fast delivery services has the potential to bring together various risk factors that can adversely affect the well-being and safety of both those involved in this industry

and other road users.

CONCLUSION

This present investigation explores and compares the characteristics of FOT with the characteristics of HUS in work-related road traffic crashes in Malaysia between 2014 and 2020. This study applies the categorical data analysis technique to examine the distinctions between FOT and HUS cases. Several factors have been discovered to increase the odds of FOT cases, including SMEs, nighttime crashes, single-vehicle crashes and sending and picking up jobs. Contradictory factors such as Malay ethnic, service and transportation sectors, Kuala Lumpur and Selangor areas, and motorcycle have been identified to decrease the odds of FOT cases compared to HUS cases. It is essential to acknowledge certain limitations within this study, primarily the restricted number of observations for FOT cases. To enhance accuracy in addressing data-related issues, it is imperative to include additional data. Additionally, some data points with fewer attributes need to be excluded from the main dataset. This process will impact the total number of observations as well. Future research endeavors should consider conducting surveys involving victims of work-related road traffic incidents to identify factors associated with the crash occurrence and injury severity. The self-reporting method is considered one of the most promising techniques, as it allows participants to articulate their own experiences instead of relying on inferences drawn from observations. Furthermore, future research also should take into account the distinct risk profiles of large enterprises as opposed to small and medium enterprises. Additional studies are warranted to clarify the road safety initiatives undertaken by each category of enterprise. Despite these limitations, the findings from this study have yielded several new insights into the factors that influence the severity of injuries among the workers who are involved in road traffic crashes by analysing the compensation data from SOCSO. These discoveries can serve as a valuable reference and guide for relevant authorities, including SOCSO and employers. This insight can inform the development of road safety programs or interventions aimed at reducing the frequency of road traffic crashes and mitigating injury severity among their workforces. The program design should particularly consider the identified high-risk groups of workers operating under diverse working conditions, as revealed by this study.

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