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RESEARCH ARTICLE

The Role of the Safety, Health and Environment Code of Practice in Mitigating Bus Crashes: A Case Study in Malaysia

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ABSTRACT - In Malaysia, bus-related road crashes, while comparatively infrequent, often result in disproportionately high numbers of fatalities, resulting in an initiative by MIROS to introduce the Safety, Health and Environment Code of Practice (SHE COP) for the transportation sector in 2007, to enhance bus safety operations and mitigate such incidents. This paper aims to assess the impact of the SHE COP implementation on bus-related road crashes and fatalities. The number of bus crashes from the year 1993 to 2022, collected from the annual road traffic accident statistics report published by the Royal Malaysia Police (RMP), was utilised. A before-after comparison for the period before and after the SHE COP was introduced was used to evaluate the statistics. The study reveals a significant decrease in bus crashes following implementation ($t_{0.025,28}$=3.066, p-value = 0.005), indicating a systemic improvement in bus safety practices. These findings underscore the effectiveness of SHE COP in reducing both the frequency of bus crashes and associated fatalities. This research provides empirical support for ongoing enhancements to SHE COP implementation within the transportation industry.

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1. INTRODUCTION

Malaysia is a developing country with rapid infrastructure development, expanding road transport, and a growing population. The increase in the number of registered vehicles and population is evident, with an average growth rate of 6% for vehicles and 1.8% for the population for the years 2000-2017 [1]. In terms of traffic volume on the road, the normal traffic growth rate was 2.74% in 2014, which translated to approximately 15,111,911 16-hour vehicle volumes. The buses contributed 0.8% to these statistics [2]. The 2019 report by the Ministry of Works highlighted that buses contributed 1.2% to the total traffic volume of 12,131,186 on the road [3]. In the year 2024, buses represented 0.8% of 13,934,734 vehicles on the road [4]. Figure 1 illustrates the national traffic composition for Malaysia. The vehicles on the road are predominantly cars (64.2%), followed by small and heavy vehicles for carrying goods (20.8%), motorcycles (14.2%), and buses (0.8%) [4]. Though the percentage of buses on the road is the smallest, the catastrophic effects are huge whenever road crashes involving buses occur [5] [6] [7] [8].

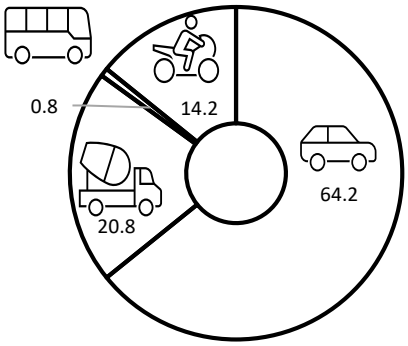

Figure 1. Traffic composition based on traffic counts on the road for Malaysia [4]

Bus accidents, especially those involving express buses, are a serious problem in Malaysia, resulting in significant loss of life and property damage. The number of crashes has been increasing yearly, with express buses accounting for 58% of all bus accidents from 2007 to 2009 [9] [10]. The statistics have not changed much, with the recent road traffic accident statistics report showing that 4,560 buses were involved in road crashes in the year 2023, with at least 45 out of 104 (43%) bus cases related to express buses [11]. This is particularly concerning because express buses are often full of passengers, putting many lives at risk in each incident. The Bukit Gantang express bus crash tragedy, which happened

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in the year 2007, claimed 22 lives [12], while a similar incident in Genting Highland in 2013 had 37 fatalities [13] [14]. Driver behaviour plays a crucial role in bus accidents, with speeding emerging as a significant risk factor [15] [16] . Excessive speed has been identified as a leading cause of crashes across all vehicle types, including commercial and public transport. Royal Malaysia Police data shows that speeding-related accidents involving drivers or riders increased from 4% in 2010 to 4.4% in 2011. Furthermore, research by the Malaysian Institute of Road Safety Research (MIROS) revealed that speeding was a contributing factor in 7.2% of bus-related accidents between 2007 and 2010 [15].

Driver fatigue is a critical factor in many bus accidents, often resulting from extended periods of driving that lead to exhaustion and reduced concentration [17] [18]. A notable incident in December 2008 illustrates this problem: an express bus plunged into a ditch at around 4 AM, causing 10 fatalities and numerous severe injuries. The early morning crash suggests that the driver may have accumulated excessive continuous hours behind the wheel, likely experiencing sleep deprivation [19] [20]. Research supports this hypothesis, indicating a higher risk of severe accidents during pre-dawn hours [12]. While the overall frequency of collisions is lowest between 2:00 AM and 6:00 AM, accidents occurring during this period tend to be more catastrophic, resulting in higher fatalities and casualties per incident [6].

(a) (b)

Figure 1. (a) A crash involving a single vehicle, an express bus; (b) The crash occurred during the early morning hours and resulted in 14 fatalities (photos are from https://www.straitstimes.com)

In terms of vehicle management, component failures are rare. When they occur, they are often due to human errors in maintenance or the use of incorrect or non-genuine materials. It is generally uncommon for a vehicle axle to detach in a crash [21] [22]; however, in a significant crash case investigated by MIROS, the front axle of a bus separated after colliding with a concrete barrier. The analysis revealed that the detachment was caused by the failure of high-tensile bolts that connected the axle to the front suspension assembly, as shown in Fig. 2. A comparative analysis with an original bolt from the chassis manufacturer indicated that the crashed bus had replaced the original bolts with substandard, lower-grade axle bolts [23].

(a) (b)

Figure 2. (a) The crash involving an express bus, (b) The front axle detached after colliding with a concrete barrier

In response to the high number of bus crashes and to improve road safety, the Malaysian government in 2007 introduced the Safety, Health, and Environment Code of Practice (SHE COP) [24], which focuses on improving five key areas: driver management, vehicle maintenance, travel planning, risk assessment, and documentation management. These key focus areas are prioritised based on crash statistics from the Royal Malaysia Police (RMP) and the Malaysian Institute of Road Safety Research (MIROS) Crash Investigation and Reconstruction team, which has been investigating many high-profile crashes since 2007. The objective of SHE COP is to provide guidance on workplace safety, raise awareness and education about health risks, and ensure public safety from work-related activities.

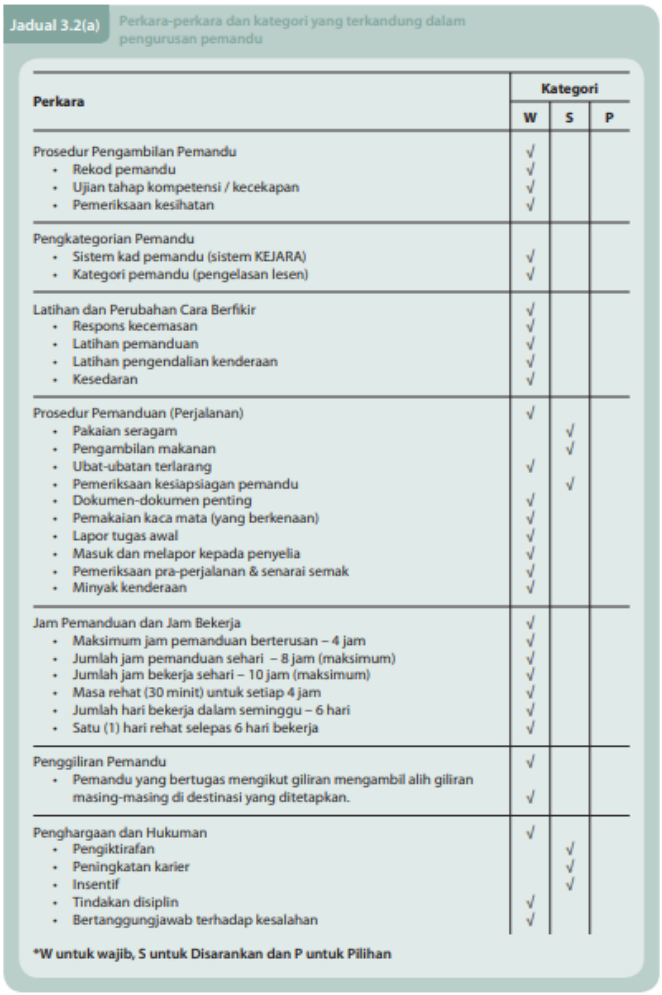
This paper highlights the essence of SHE COP and its continuous improvement for the road transport sector. The code has been in place since 2008, and it is timely to quantify the effect of having a SHE COP. Hence, this study attempted to investigate the effect of the SHE COP, in mitigating the number of bus crashes using a quantitative approach, a before-

after study. This is crucial as it provides evidence for road safety prevention and management. The result could serve as a strong basis for intervention analysis to strengthen the effort in promoting the safer operation of bus operators.

2. THE DEVELOPMENT OF THE SAFETY, HEALTH AND ENVIRONMENT CODE OF PRACTICE

Despite the increasing trend of crashes involving express buses in the country, the government has intensified its focus on enhancing safety in the commercial vehicle transportation sector. One of the key initiatives has been the formulation of the Safety, Health, and Environment Code of Practice for the Transportation Sector in 2007 (SHE COP) [24], specifically tailored for the transportation industry. MIROS spearheaded the development of the SHE COP through close collaboration and active involvement from relevant government agencies, industry stakeholders, and Non-Governmental Organisations (NGOs). The development of the SHE COP is based on the Plan-Do-Check-Act (PDCA) Model, a widely used framework in safety and health management [25]. The key elements are Policy, Organisation, Planning and Implementation, Evaluation, and Action for Improvement. The SHE COP emphasises the necessity of establishing a safety and health policy and organising a dedicated safety and health framework within the company. Additionally, it highlights the need for systematic planning and implementation of standard operating procedures related to driver management, vehicle management, journey and risk management, and document management.

This SHE COP is designed to address critical safety issues in operations, such as driver, vehicle, and journey management, promote health standards, and ensure continuous improvement within the sector, reflecting the government's commitment to reducing accidents and improving overall safety standards in commercial transportation. The important elements in the SHE COP include the employer's role in establishing a safety policy and communicating it effectively, the standard operating procedures for drivers' management, vehicles, journeys, and risk management, as well as proper documentation and records throughout the operation. All elements are then evaluated through audits, and actions for improvement are suggested. Acknowledging the importance of having a good driver, the SHE COP listed its mandatory, suggested, and desirable aspects in driver management. This includes health screening and competency training, suggested working and driving hours for drivers, and a reward system, as shown in Figure 3, among other measures. A similar approach for vehicle management, where vehicles need to adhere to R66 ECE or equivalent for the bus structure and undergo routine maintenance. Under risk and journey management, the hazards along the route are mapped, and a proper surveillance system should be in place [24].



Jadual 3.2(a) Perkara-perkara dan kategori yang terkandung dalam pengurusan pemandu

Perkara	Kategori		
	W	S	P
Prosedur Pengambilan Pemandu	√		
• Rekod pemandu	√		
• Ujian tahap kompetensi / kecekapan	√		
• Pemeriksaan kesihatan	√		
Pengkategorian Pemandu			
• Sistem kad pemandu (sistem KEJARA)	√		
• Kategori pemandu (pengelasan lesen)	√		
Latihan dan Perubahan Cara Berfikir	√		
• Respons kecemasan	√		
• Latihan pemanduan	√		
• Latihan pengendalian kenderaan	√		
• Kesedaran	√		
Prosedur Pemanduan (Perjalanan)	√		
• Pakaian seragam		√	
• Pengambilan makanan		√	
• Ubat-ubatan terlarang	√		
• Pemeriksaan kesiapsiagan pemandu		√	
• Dokumen-dokumen penting	√		
• Pemakaian kaca mata (yang berkenaan)	√		
• Lapor tugas awal	√		
• Masuk dan melapor kepada penyelia	√		
• Pemeriksaan pra-perjalanan & senarai semak	√		
• Minyak kenderaan	√		
Jam Pemanduan dan Jam Bekerja	√		
• Maksimum jam pemanduan berterusan – 4 jam	√		
• Jumlah jam pemanduan sehari – 8 jam (maksimum)	√		
• Jumlah jam bekerja sehari – 10 jam (maksimum)	√		
• Masa rehat (30 minit) untuk setiap 4 jam	√		
• Jumlah hari bekerja dalam seminggu – 6 hari	√		
• Satu (1) hari rehat selepas 6 hari bekerja	√		
Penggiliran Pemandu	√		
• Pemandu yang bertugas mengikut giliran mengambil alih giliran masing-masing di destinasi yang ditetapkan.	√		
Penghargaan dan Hukuman	√		
• Pengiktirafan		√	
• Peningkatan karier		√	
• Insentif		√	
• Tindakan disiplin	√		
• Bertanggungjawab terhadap kesalahan	√		

*W untuk wajib, S untuk Disarankan dan P untuk Pilihan

Figure 3. A snapshot of the standard operating procedure in driver management [24]

In the initial process, the introduction of the SHE COP in the transportation industry was voluntary, as there were no specific acts or regulations mandating its adoption; hence, it resulted in low implementation and adaptation by the industry. However, in 2010, the Department of Occupational Safety and Health (DOSH) took the initiative to revise the content and scope of the code and gazette it under sub-section 37(4) of the Occupational Safety and Health Act 1994 [26] so it could be implemented more effectively. With the assistance and cooperation of relevant government agencies, NGOs, and industry, DOSH has formulated a new code known as the Occupational Safety and Health Industry Code of Practice for Road Transport Activities 2010 (ICOP 2010) [27]. Consequently, all industries related to road transport activities, including the bus industry, logistics, and transportation sectors, are obligated to comply with the ICOP 2010.

Subsequently, in the year 2010, the Land Public Transport Commission (LPTC) was established, taking on the responsibility of managing public road transportation in the country. Some of LPTC's functions are to plan, set policies, enforce laws and regulations relating to operating licenses and safe operation. In 2013, LPTC introduced two Industrial Codes of Practice for bus operators [28] and goods vehicles [29]. Findings from crash investigations conducted by the Malaysian Institute of Road Safety Research revealed that driver management issues are significant factors contributing to bus-related crashes. Consequently, driver management is a key component of both the SHE COP and the ICOP 2010, as well as the SPAD ICOP 2013. Despite the evolution of the SHE COP, its primary aim remains to improve safety and health compliance among operators and to reduce the incidence of crashes and injuries involving commercial vehicles.

In addition to the Code of Practices previously mentioned, several voluntary initiatives have been introduced to complement existing regulations and enhance safety and health in bus operations (refer to Figure 4). For example, the Safety Star Grading Program (SSG) [30] for bus operators was launched in 2012. This program evaluates bus operators' operations and performance based on five key components: Safety, Health, Comfort, and Safety Performance. Additionally, the introduction of the Road Safety Management System ISO 39001, along with its voluntary adoption, further supports the advancement of road traffic safety management. Following the initiatives, the SSG has been discussed at the ministry level and has been named Malaysia Bus Star Rating (MBSR) to make it mandatory for operators to comply with.

Figure 4. A summary of the continuous initiatives to improve the safety operations of the bus industry

3. METHODOLOGY

The data on road crashes involving buses was collected from the Annual Road Accident Statistics, produced by the Royal Malaysia Police, starting in 1993 to 2022, with a total observation of 30 data points. The data refers to all road crashes involving buses, regardless of the type of bus involved. This includes express buses, stagecoaches, school buses, factory buses, and other types of buses. Data is presented in a line chart to show the overall trend. The data is segregated into two groups: before the year 2008, referred to as the 'before' group, and the rest as the 'after' group. A descriptive statistic for both groups includes the minimum and maximum number of crashes, and the mean and standard deviation are presented within a boxplot.

A hypothesis test was conducted, with the null hypothesis stated as there is no difference in the mean number of road crashes before and after the SHE COP, against the alternative hypothesis. An independent t-test is performed to investigate the differences between the number of crashes for the period before and after the SHE COP is implemented. The independent t-test is a statistical method which compares the means of two independent groups, with the aim of determining whether there is statistical evidence that the associated population means are significantly different. It is a parametric test, with unequal variances assumed, in this case. The two groups are considered independent since there is no guarantee that the same operators are in business for both periods before and after. The null hypothesis of no differences in the mean number of bus crashes for both periods is tested using the following test statistics, as shown in Equation 1, assuming unequal variances:

$$Test\ statistics\ T_0 = \frac{(\overline{X_1} - \overline{X_2}) - \Delta_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (1)$$

where $\overline{X_1}$ = mean of before the SHE COP implementation, $\overline{X_2}$ = mean of after the SHE COP implementation, s_1^2 is the standard deviation of before, s_2^2 is the standard deviation of after, n_1 and n_2 are the sample size of respected group 1 (before) and the group 2 (after). The calculated t value is then compared to the critical value t from the t distribution table with degrees of freedom as shown in Equation 2:

$$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1 - 1}\left(\frac{s_1^2}{n_1}\right)^2 + \frac{1}{n_2 - 1}\left(\frac{s_2^2}{n_2}\right)^2} \quad (2)$$

at a 95% confidence level. If the calculated t-value > critical value t, then there is enough evidence to reject the null hypothesis.

4. RESULTS

Table 1 presents the statistics of road crashes involving buses before and after SHE COP was introduced, illustrated in the boxplot below. The mean and median after the implementation of SHE COP are much lower than in the before group.

Table 1. Descriptive statistics for crashes involving buses

Group	Mean (s.d)	n	Min	Max	Median
Before SHE COP	10,051.8 (928.6)	15	8,594	12,165	9,721
After SHE COP	7,808.7 (2,676.7)	15	2,416	10,617	9,193
Total	8,930.3 (2,275.2)	30	2,416	12,165	9,521

(s.d) represent the standard deviation

The boxplot shows the minimum number of crashes, and the vertical line inside the box is the median or the second quartile (Q2) value. The vertical line on the top shows the third quartile (Q3), and the bottom shows the first quartile (Q1). The first box represents summaries for the 'After' period, and the second represents summaries for the 'Before' period.

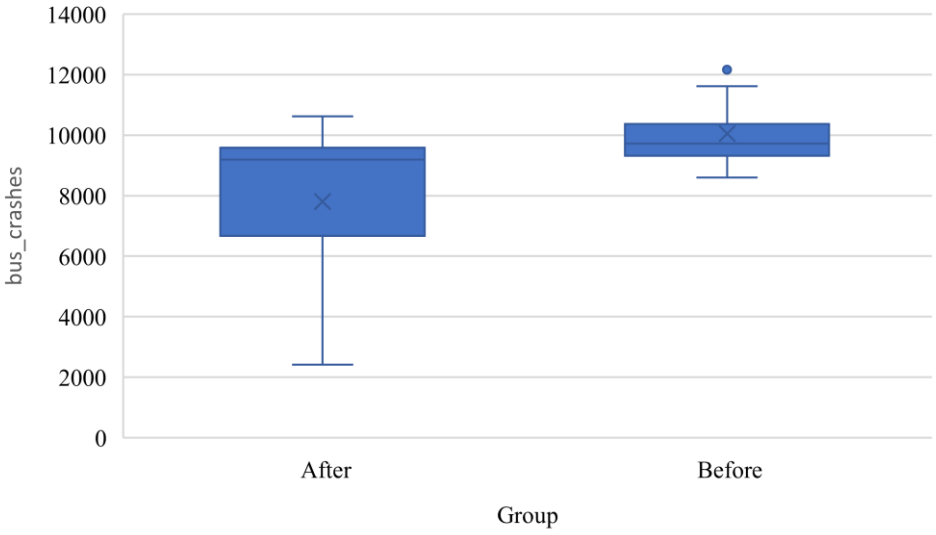


Figure 5: Boxplot shows two-group comparison of before and after SHE COP implementation

If observed, the boxplot shows a difference in the median line (Q2) between before and after the implementation of SHE COP. The median line also shows a higher value for the 'before' group than the 'after' group. Based on the descriptive statistics and the boxplot, a test of difference in means is suggested.

Table 1 shows descriptive statistics that the mean of group 1 (before) is 10,051.8 and the mean of the other group is 7,808.7. The mean difference is 2,243.1, with an equal sample size of 15 observations. The independent t-test was conducted to test whether the difference is significant. The independent t-test results in Table 2 yield the test statistics of $t\text{-value}_{0.025,28}=3.066$, and p-value = 0.007, equal variances not assumed, indicating that the data shows enough evidence to reject the null hypothesis. Hence, there is a significant difference in the number of bus crashes before the year 2008 and after the SHE COP is introduced. The results suggest that an intervention could have happened that brought the positive effect of crash reduction, in this case, the introduction of the SHE COP for the transportation sector.

Table 2. Independent samples t-test for crashes involving buses

Group	Mean (s.d)	n	Mean difference (s.e)	t (p-value)	df
Before SHE	10,051.8 (928.6)	15	2,243.1(731.5)	3.066 (0.007)	28
After SHE	7,808.7 (2,676.7)	15			

(s.d) represent the standard deviation, (s.e.) represent standard error

Figure 5 below illustrates the annual number of bus crashes from 1983 to 2022. The series shows several peaks and a decreasing trend. The highest number of bus crashes was in 2004, with 12,165 crashes. At the beginning of the series, 1997, there were 11,620 cases, and in 2012, there were 10,617 crashes. A reference line was added to the line chart in 2008, indicating the starting point of the SHE COP. In the series, an apparent reduction in crashes occurred after 2008, and the series had reduced further towards the end.

Figure 6. The annual number of bus crashes shows a decreasing trend

The significant reduction in crashes was further seen from the year 2013 onwards. However, there were circumstances where the presence of COVID-19 in the years 2020 and 2021, Malaysia was in a series of lockdown periods. The lockdown has affected many sectors, including transport and indirectly contributed to lower road crashes. In 2022, the number of crashes was observed to slightly increase as the traffic and lockdown restrictions were lifted.

5. CONCLUSION

All fatal road crashes are tragedies, but the involvement of buses in any fatal crashes usually results in higher fatalities due to the number of passengers they carry. The introduction of the SHE COP in 2007 catalysed the improvement of the road safety situation in the country, aiming at reducing the number of bus crashes. This paper illustrates the history of SHE COP and its development, which enables stringent enforcement and evaluation. Road crash statistics involving buses were extracted from the Royal Malaysia Police from 1993 to 2022. This paper aims to investigate the effectiveness of the SHE COP in reducing the number of crashes, quantitatively using descriptive statistics and a t-test for differences in means.

A systematic approach for safer operation in transport industries was introduced in 2007, outlining important improvement elements. The SHE Code of Practice for the transportation sector was developed based on the five iterative concepts, Policy, Organisation, Plan, Evaluate and Action for improvement. This SHE COP emphasised a standard

operating procedure for the whole driver, vehicle, journey, and proper record maintenance loop. The aim is to improve the overall transportation system by ensuring safer operations by transport operators. The following SPAD iCOP strengthened the implementation on the ground, and the result was a reduced number of road crashes involving buses. The introduction of SHE COP for the transport sector serves as a basis for the Industrial Code of Practice for the Transportation Sector, gazetted under OSHA in 2010. In 2012, the Land Public Transport Commission (SPAD) enhanced the code as the Industrial Code of Practice Safety Programme for Buses.

The series of SHE COP improvements shows the government's commitment to reducing the number of crashes, especially for heavy vehicles and buses. This paper presents a quantitative analysis to assess the effectiveness of having the SHE COP. Independent t-test results show a significant reduction in the number of bus crashes following the introduction of the SHE COP in the year 2008 and beyond. Several factors could be attributed to reduced bus crashes; however, this result suggests an improvement due to a policy change, which refers to an intervention. For the bus industry, continuous improvement, as reflected in the list of initiatives, plays a significant role in shaping a safer bus operation.

This paper is not without a flaw. There are many other ways to evaluate the effectiveness of an intervention. However, this paper uses the simple independent t-test as the initial evaluation. A comparison with another group of modes of transport would produce a better result, but the data could not be obtained at this point in time. On a similar note, further analysis using time series intervention analysis could be explored, as the data is collected over time.

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AUTHOR CONTRIBUTIONS

Rohayu Sarani: Conceptualisation, Methodology, Writing- Reviewing and Editing, Statistical analysis

Ilhamah Othman: Data curation, Writing- Original draft preparation.

Zarir Hafiz Zulkifli: Crash Visualisation, Writing-Original draft.

Mohamad Sufian Ahmad.: Writing- Reviewing

Zulhaidi Mohd Jawi@ Said: Reviewing

Siti Zaharah Ishak: Supervision.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are included within the article.

REFERENCES

[1] S. Rohayu, H. Rizati, S. M. R. Sharifah Allyana, R. Azzuhana, J. Nurulhuda, and H. Nur Zarifah, "Road Safety in Malaysia," in *Proceedings of the 2nd Conference of ASEAN Road Safety 2018*, Putrajaya, 2018, pp. 128-133.

[2] Ministry of Works, Malaysia, "Road Traffic Volume Malaysia, 2014," Malaysia, 2015.

[3] Ministry of Works, Malaysia, "Road Traffic Volume Malaysia, 2018," Malaysia, 2019.

[4] Ministry of Works, Malaysia, "Road Traffic Volume Malaysia 2024," Highway Planning Division, Ministry of Works Malaysia, Kuala Lumpur, 2024.

[5] A. L. Patwary, "Bus safety during COVID-19: Analyzing bus-involved crashes and economic harm," *International Journal of Crashworthiness*, vol. 29, no. 1, pp. 178-185, 2024.

[6] Y. Fadhli, H. Zarir, S. Sharifah Allyana, M. Norlen and S. Wong, "Road collision involving express buses travelling at wee hours (12.00 - 6.00 am): MIROS Evaluation Report 04/2009," Malaysian Institute of Road Safety Research, Kuala Lumpur, 2009.

[7] N. Manap, M. N. Borhan, M. M. R. Yazid, and N. A. Wahid, "An overview of heavy vehicle accidents characteristic on expressways in Malaysia," *IOP Conference Series: Material Science and Engineering*, vol. Volume 1144, no. 1, pp. 012087, 2021.

[8] C. G Prato and S. Kaplan, "Bus accident severity and passenger injury: Evidence from Denmark," *European Transport Research Review*, vol. 6, no. 1, pp. 17-30, 2014.

[9] Royal Malaysia Police, "Statistical Report of Road Accident Malaysia," Bukit Aman Traffic Branch, Kuala Lumpur, 2008.

[10] Royal Malaysia Police, "Statistical Report of Road Accidents Malaysia," Bukit Aman Traffic Branch, Kuala Lumpur, 2010.

[11] Jabatan Siasatan dan Penguatkuasaan Trafik, "Laporan Perangkaan Kemalangan Jalan Raya Malaysia," Ibu Pejabat Polis Bukit Aman, Kuala Lumpur, 2023.

[12] M. Othman, S. Rohayu, H. Zarir, P. Noor Faradila, and S. Wong, "The Effect of Driver Management System According to SHE COP in Reducing Speed Violations: MRR 11/2009," Malaysian Institute of Road Safety Research, 2009.

[13] Z. A. A. N. Syukri, M. J. Zulhaidi, D. W. Kak, M. R. M. Amirudin, and A. K. K. Anwar, "Establishment of an independent safety board in Malaysia: A case study of the Genting Highlands bus crash," *Journal of Advanced Research in Occupational Safety and Health*, vol. 6, no. 1, pp. 1-8, 2019.

[14] The Independent Advisory Panel to The Minister of Transport Malayia, "A Report on Genting Highlands Bus Crash," Malaysian Institute of Road Safety Research (MIROS), Putrajaya, 2014.

[15] Z. Ahmad Noor Syukri, M. Siti Atiqah, L. Fauziana and A. Abdul Rahmat, "MIROS Crash Investigation and Reconstruction Annual Statistical Report 2007-2011: MRR 05/2012," Malaysian Institute of Road Safety Research (MIROS), Kuala Lumpur, 2012.

[16] N. Isah and N. F. Mohd Soid, "Analysis of factors associated with speeding among road users in Malaysia," *Advances in Human Aspects of Transportation: Part I*, vol. 15, no. 15, pp. 1-8, 2021.

[17] N. Mohamed, M. F. Yusoff, I. Othman, Z. H. Zulkipli, M. R. Osman, and S. V. Wong, "An impact assessment of banning wee-hour express bus operations," *Injury Prevention*, vol. 16, no. Suppl 1, pp. A81-A81, 2010.

[18] J. Davidovic, D. Pesic, and B. Antic, "Professional drivers' fatigue as a problem of the modern era," *Transprtation Research Part F: Traffic Psychology and Behavior*, vol. 55, pp. 199-209, 2018.

[19] J. May and C. Baldwin, "Driver Fatigue: The importance of identifying causal factors of fatigue when considering detection and countermeasure technologies," *Transportation Research Part F: Traffic Psychology and Behaviour*, vol. 12, no. 3, pp. 218-224, 2009.

[20] D. Dawson and K. Reid, "Fatigue, alcohol and performance impairment," *Nature*, vol. 235, p. 388, 1997.

[21] National Transportation Safety Board (NTSB), "Highway accident report: Motorcoach roadway departure and overturn on US Highway 83 near Laredo, Texas," NTSB, 2016.

[22] D. Blower and K. L. Campbell, "The large truck crash causation study," University of Michigan Transportation Reserach Institute (UMTRI), 2002.

[23] Z. H. Zulkipli, S. A Mohd Faudzi, K. D Wing, A. N. S Zainal Abidin, I. Abdul Hamid, F. Lamin, et al., "Failure analysis in vehicular crash reconstruction," *Journal of the Society of Automotive Engineers Malaysia*, vol. 7, no. 3, pp. 150-160, 2024.

[24] Malaysian Institute of Road Safety Research, "Kod Amalan Keselamatan, Kesihatan dan Alam Sekitar untuk Sektor Pengangkutan," Malaysian Institute of Road Safety Research (MIROS), 2007.

[25] R. A. Sofian Bastuti, "Safety riding analysis using the PDCA concept for plumbing fitting industry employees in Tangerang," *Jurnal Ilmiah Teknik Industri*, vol. 21, no. 2, pp. 135-141, 2022.

[26] Department of Occupational Safety and Health, Occupational Safety and Health Act 1994 (Act 514), Kuala Lumpur: The Commissioner of Law Revision, Malaysia, 1994.

[27] Ministry of Human Resources, "Occupational Safety and Health Industry Code of Practice for Road Transport Activities 2010," Department of Occupational Safety and Health, 2010.

[28] The Land Public Transport Commission (SPAD), *Buku Panduan S.P.A.D. ICOP - Keselamatan dan Kod Amalan Industri S.P.A.D - Keselamatan untuk Pengendali Bas*, The Land Public Transport Commission (SPAD), 2016 (Second Edition).

[29] The Land Public Transport Commission (SPAD), *Buku Panduan S.P.A.D ICOP - Keselamatan dan Kod Amalan Industri S.P.A.D - Keselamatan untuk Pengendali Berlesen Perkhidmatan Kenderaan Barangan*, Putrajaya: The Land Public Transport Commission (SPAD), 2015, (Second Edition).

[30] M. S. Ahmad, W. Ameer Batcha, I. Othman and A. H. Ariffin, "Development of safety star rating system for express bus operator in Malaysia," *Journal of the Society of Automotive Engineers Malaysia*, vol. 5, no. 2, pp. 306-317, 2021.

[31] C. G. Prato and S. Kaplan, "Bus accident severity and passenger injury: Evidence from Denmark," *European Transport Research Review*, pp. 17-30, 2014.

[32] S. Thobias, E. Mtoi and M. Ren, "Potential causes of driver fatigue: A study on transit bus operators in Florida," *Transportation Research Board 90th Annual Meeting*, Washington DC, United States, 2010, pp. 1-15.