

# Evaluation of Non-Compliant Road Furniture on Urban Road Safety: A Case Study of Jalan Kinta, Perak Darul Ridzuan (FT001 Section 606.85 to 607.85)

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## Abstract

Over 2016-2023, road crash data in Malaysia exhibited a consistent upward trend, with a temporary decline during the COVID-19 pandemic attributed to reduced road users. This study investigates non-compliance road furniture and analyses its correlation with road accidents in Perak, Malaysia, along FT001 from Section 606.85 to 607.85. The study includes spot speed and traffic volume analysis using data from the Malaysian Public Works Department (JKR) Kinta District. Findings indicate that 37% of non-compliance road furniture requires urgent attention. However, weak and statistically insignificant correlations were observed between non-compliance road furniture and road accidents in the area, supporting previous research by MIROS emphasizing the human factor as the primary contributor to road safety 80% and followed by other factors.

## 1. Introduction

Road accidents have far-reaching impacts on countries, encompassing human casualties, economic burdens, injuries, traffic congestion, and societal consequences. Throughout the eight years from 2016 to 2023, the analysis of road crash data in Malaysia reveals a persistent upward trend as shown in Table 1. The temporary reduction in crash numbers during the COVID-19 pandemic is solely attributed to decreased road users. Addressing road safety is crucial to mitigate adverse effects on tourism and investment. Road furniture, encompassing physical elements like signs and barriers, is pivotal in enhancing road safety by guiding users and improving visibility (Abd Rahman et al. 2023). Despite numerous safety measures, road accidents persist, necessitating a deeper understanding of their root causes.

**Table 1** Accident Data in Malaysia (RMP, 2022)

Year	2016	2017	2018	2019	2020	2021	2022
Road Crash	521,446	533,875	548,598	567,516	418,237	370,286	545,580
Road Fatality	7,152	6,740	6,284	6,167	4,634	4,539	6,080

The study objectives are to assess non-compliance road furniture in urban areas and analyze its correlation with road accidents. The study focuses on assessing the compliance and impact of various road furniture elements in promoting road safety. It includes an analysis of different types of road furniture in urban environments. This research holds significance in addressing the global public health concern of road accidents. With over 1.2 million annual deaths and 50 million injuries worldwide from road accidents, it is predicted to become the fifth leading cause of death by 2030 (World Health Organization, 2017). Hence, the research aims to identify contributing factors, evaluate current safety measures, and guide the development of effective policies. Beyond saving lives, the study's outcomes can inform diverse disciplines like public health, law enforcement, urban planning, and transportation, enhancing road infrastructure and safety campaigns.

The Malaysian Road system, divided into federal, state, and local municipal roads, relies on factors like human behavior, vehicle characteristics, and environmental conditions for safety. This study explores various road furniture types, such as traffic signs, signals, streetlights, kerbs, and markings, in line with Malaysian standards. It will scrutinize these elements, ensuring compliance with regulations. For example, road markings and signs play a crucial role in influencing driver behavior and enhancing road safety. However, it is not enough for them to exist; they must also be of good quality and effectively visible in various weather and traffic conditions (Babić et al. 2022). The correlation between deviations from prescribed norms and the incidence of accidents will be scrutinized, employing rigorous statistical methodologies. This multifaceted analysis aims to discern patterns, trends, and causal relationships that may inform targeted interventions and policy adjustments to enhance overall road safety.

## 2. Methodology

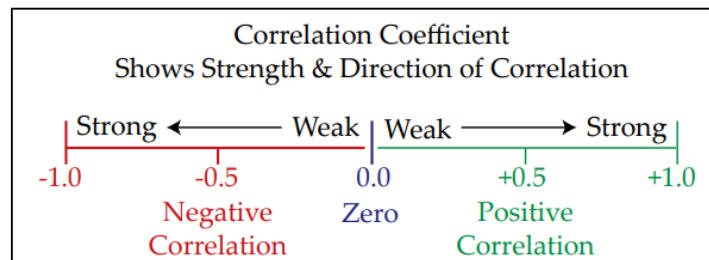
The preliminary stage of the study entails gaining a comprehensive understanding and conducting an in-depth analysis of the study area. The study focuses on Perak, the second-largest state in Peninsular Malaysia, comprising 12 districts, with a road network spanning 40,076.133 kilometers. Perak exhibits a concerning trend despite its extensive road infrastructure, ranking among the highest in Road Traffic Collision (RTC) rates in Malaysia, recording 30,669 RTC cases and 491 fatalities in 2020 alone (Public World Department, 2022). The data for this study was collected over a period from 2020 to 2023, providing a comprehensive overview of recent traffic patterns and road safety concerns. Specifically, in the Kinta District, 124 road accidents were recorded during this period, with 11 accidents occurring within the study area (sections 606.85 to 607.85). Subsequent analysis unveils a prevailing categorization of these incidents: 1 classified as severe, 6 as minor, and 4 as unspecified, thereby elucidating the severity of road safety concerns within the region, as depicted in Fig. 1 below.

No	Road Categories	Road Number	Section Number	Type of Accident	Surface Type	Road Condition	Surface Quality	Weather	Road Type	Road Surface	Lighting
1	UNSPECIFIED	FT001	607.80	SEVERE	BRICK PAVING	FLAT	FLAT	GOOD	JUNCTION	DRY	NIGHT
2	STATE	FT001	607.81	MINOR	BRICK PAVING	FLAT	FLAT	GOOD	JUNCTION	DRY	NIGHT
3	FEDERAL	FT001	607.20	UNSPECIFIED	BITUMEN/TAR PAVING	FLAT	FLAT	GOOD	JUNCTION	DRY	DAY
4	UNSPECIFIED	FT001	606.98	MINOR	BRICK PAVING	FLAT	FLAT	GOOD	JUNCTION	DRY	NIGHT
5	UNSPECIFIED	FT001	607.00	UNSPECIFIED	BITUMEN/TAR PAVING	FLAT	FLAT	GOOD	STRAIGHT	DRY	DAY
6	STATE	FT001	607.20	MINOR	BITUMEN/TAR PAVING	FLAT	FLAT	GOOD	JUNCTION	DRY	NIGHT
7	STATE	FT001	607.10	MINOR	BITUMEN/TAR PAVING	FLAT	FLAT	GOOD	JUNCTION	DRY	DAY
8	UNSPECIFIED	FT001	607.30	MINOR	BITUMEN/TAR PAVING	FLAT	FLAT	GOOD	STRAIGHT	DRY	DAY
9	UNSPECIFIED	FT001	607.20	UNSPECIFIED	BRICK PAVING	FLAT	FLAT	GOOD	STRAIGHT	DRY	DAY
10	STATE	FT001	607.40	UNSPECIFIED	BITUMEN/TAR PAVING	FLAT	FLAT	GOOD	JUNCTION	SANDY	DAY
11	FEDERAL	FT001	607.60	MINOR	BRICK PAVING	FLAT	FLAT	GOOD	STRAIGHT	DRY	NIGHT

**Fig. 1** Road Accidents at Section 606.85 to 607.85 from 2020-2023

Next, the study executes a spot speed study and the assessment of traffic volume within the designated study area to unravel the complexities of traffic behavior by synthesizing the variables of speed, volume, and traffic patterns. After this phase, a pivotal facet of the research involves an in-depth analysis of road furniture compliance, centering on its evaluation in accordance with established standards and regulations specifically the Malaysian Road Safety Standards (JKR), which provide clear guidelines on the design, installation, and maintenance of road signs, streetlights, and markings. For example, according to the Malaysian Road Safety Standard Section 8: Traffic Signal System (2008), regulatory traffic signs must maintain a minimum reflectivity to ensure visibility at night or in adverse weather conditions. However, in the study area, several traffic signs were found to have faded and were obstructed by advertisements, rendering them non-compliant with visibility standards. Following the evaluation of compliance, the imperative phase of data analysis commences, involving a meticulous examination of both primary and secondary data sources. This analytical process is designed to identify correlations between non-compliance with road furniture and the occurrence of road accidents, thereby contributing to a more nuanced understanding of the factors influencing road safety. To facilitate the analysis, the study employs Statistical Package for the Social Sciences (SPSS), which is a statistical software and utilizes

the Pearson Correlation method to assess the presence and strength of relationships between two distinct variables. The correlation results as illustrated in Fig. 2, are categorized based on their significance. Significant correlation is acknowledged when the p-value falls below 0.05, emphasizing the critical role of statistical significance in the interpretation of the study's outcomes.



**Fig. 2** Correlation Coefficient Ranges Scale (Gogtay and Thatte, 2017)

### 3. Results and Discussion

Fig. 3, created using QGIS and provided data, precisely maps road accidents in specific sections. There were 6 reported accidents on the journey from Kuala Kangsar to Ipoh, while conversely, 5 accidents were recorded from Ipoh to Kuala Kangsar. A more detailed analysis reveals that two accidents occurred at the exact location along the route from Ipoh to Kuala Kangsar. Furthermore, accidents were differentiated using color-coded symbols. Yellow symbols denoted severe accidents, while green symbols indicated minor accidents. The visual representation enables a quick and clear assessment of each accident's severity.



**Fig. 3** Accident Occurred Along Section 606.85 to 607.85 from 2020-2023

Spot speed study on the area identified the 85th percentile speeds on the Ipoh to Kuala Kangsar and Kuala Kangsar to Ipoh roads as 56 km/hr and 77 km/hr, respectively. Notably, these speeds fall below the designated speed limit of 90 km/hr for the road, constructed under the JKR R5 road standard. The study's revelation that the mean speeds are below the speed limit implies a general adherence to prescribed regulations, suggesting a positive trend toward maintaining safe driving speeds. In a nutshell, the comprehensive observation of vehicle speeds along both roads within the study area, covering the Section 606.85 to 607.85 stretch, indicates that speed, as a factor, does not significantly contribute to road accidents. Despite variations in 85th percentile speeds between the two road segments, overall compliance with speed limits implies responsible driving behavior among motorists. This underscores the importance of enforcing and maintaining speed regulations to ensure road safety in the study area. Finally, the estimated traffic volume for the study area is 3216 vehicles per day.

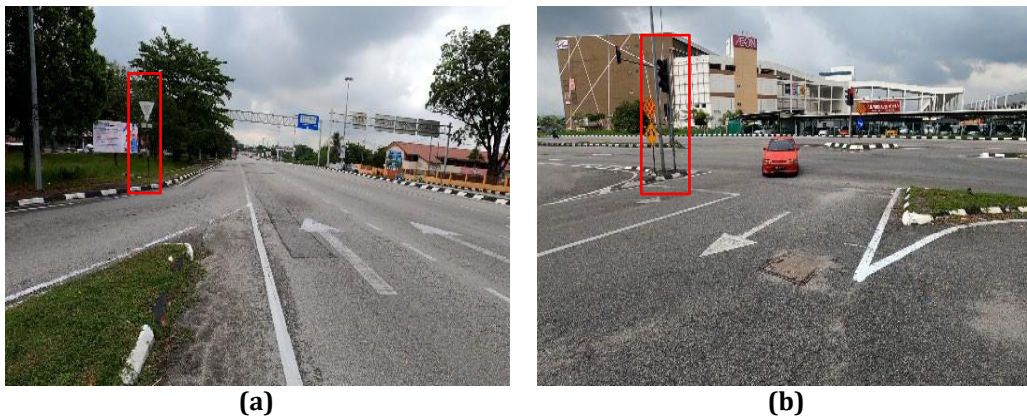
#### 3.1 Evaluation of Road Furniture

Next, examining the conditions of road furniture on roads sections 606.85 to 607.85, as shown in Fig. 4, is the primary focus of this study, aiming to evaluate the non-compliance road furniture along the roads to promote safer roadways and improved traffic flow. The investigation was made in spans of two legs of the journey, encompassing the route from Ipoh to Kuala Kangsar and back. Then, the investigation of road furniture was covered thoroughly in terms of compliance with the standards and regulations.



**Fig. 4** Study Location

Firstly, the study identified significant issues with traffic signs, including breakage, fading, and obstruction by stall advertisements. Furthermore, the visibility of certain signs was compromised due to overgrown trees. These shortcomings pose a considerable risk to road users, as clear and visible signage is crucial for effective communication and guidance. Next, Fig. 5a exhibits non-compliance regulatory traffic signs in the study area, providing visual illustrations of the discussed road furniture conditions. In addition, non-functioning traffic signals were observed, impacting the regulated flow of traffic. The malfunction of these signals introduces an element of unpredictability and can lead to congestion, disruptions, and, most importantly, safety hazards. Addressing these issues is crucial to maintaining a smooth and organized traffic system. Fig. 5b displays instances of traffic signal non-compliance in the study area, offering visual representations of the discussed road furniture conditions.



**Fig. 5** Road Furniture Condition (a) Faded Regulatory Traffic Sign; (b) Malfunction Traffic Signal

Moreover, the analysis of streetlights exposed noteworthy concerns. Several lights were found to have malfunctioned bulbs, contributing to poorly lit sections. The absence of streetlights in certain areas was even more alarming, creating potential hazards for drivers and pedestrians. Adequate street lighting is fundamental for ensuring visibility and overall safety, and the identified deficiencies must be promptly addressed. As an illustration, Fig. 6a showcases non-compliance streetlights in the study area, offering visual representations of the discussed road furniture conditions. Then, issues related to kerbs were also documented, including missing kerbs and failing to install them after construction completion. Properly installed and maintained kerbs are vital for delineating road edges and enhancing overall safety. Fig. 6b presents an illustrative example of a kerb within the study area. These visual depictions provide a tangible perspective on the condition of road furniture, featuring specific instances of kerbs that reflect the broader findings discussed in the comprehensive examination.



**Fig. 6** Road Furniture Condition (a) Malfunction Streetlight; (b) Missing Kerbs

Lastly, the analysis revealed that road markings on paving surfaces diminish their clarity and effectiveness. Additionally, faded markings were identified, contributing to potential confusion among road users. Clear and well-maintained road markings are essential for guiding drivers and ensuring orderly traffic flow. For example, Fig. 7 showcases instances of road marking non-compliance in the study area, offering visual representations of the discussed conditions related to road furniture.



**Fig. 7** Faded Road Making

Not to forget, the size of the medians in the study area does not follow the standard requirement of a 1.5-meter minimum width as it is classified under arterial urban road U4. However, design exception is permissible in the area where the width of the median is 1 meter with a condition of traffic volumes of less than 4000 vehicles per day about road widening factors. Overall, the findings underscore the urgency of addressing the identified flaws in road furniture within the study area. The deficiencies pose significant risks to road safety and traffic efficiency. Immediate corrective measures are necessary, including repairs, replacements, and enhanced maintenance protocols. This study emphasizes the critical role of meticulous infrastructure management in creating roadways that prioritize the safety and well-being of all users.

### 3.2 Data Analysis

The correlation between non-compliance road furniture and accidents is crucial to road safety analysis. The correlation explores how violations or neglect of proper road infrastructure and markings contribute to traffic accidents. Hence, the 1-kilometre section has been subdivided into 10 sections, each 100 meters long, to facilitate a more precise analysis of the study area. The result of the study in Table 2 shows an overall 40% non-compliance road furniture along 1 kilometer from Ipoh to Kuala Kangsar with 5 accidents along the way since 2020-2023.

**Table 2** Results of Non-Compliance Road Furniture by section from Ipoh to Kuala Kangsar

Section	1	2	3	4	5	6	7	8	9	10
No. of accidents at the section	1	0	0	2	0	0	2	0	0	0
No. of Non-Compliance Road Furniture	2	2	3	2	1	2	2	2	2	2
No. of Road Furniture	5	6	5	5	5	5	6	4	4	6
Results (%)	40	33	60	40	20	40	33	50	50	33
Overall (%)	40									

The result of the study in Table 3 shows that there has been an overall 34% non-compliance road furniture along 1 kilometer from Kuala Kangsar to Ipoh, with 6 numbers of accidents along the way from 2020- 2023.

**Table 3** Results of Non-Compliance Road Furniture by section from Kuala Kangsar to Ipoh

Section	1	2	3	4	5	6	7	8	9	10
No. of accidents at the section	3	0	0	1	0	0	1	0	1	0
No. of Non-Compliance Road Furniture	2	0	1	3	1	2	4	2	2	1
No. of Road Furniture	6	6	5	6	4	5	6	4	6	5
Results (%)	33	0	20	50	25	40	67	50	33	20
Overall (%)	34									

The Pearson correlation coefficients calculated for the correlation between non-compliance road furniture and road accidents from Ipoh to Kuala Kangsar and vice versa yielded exciting insights, as shown in Table 3. The Pearson correlation coefficient for the direction from Ipoh to Kuala Kangsar is -0.156, with a two-tailed significance value of 0.666. The negative correlation suggests a weak inverse relationship between non-compliance road furniture and the occurrence of road accidents along the route. However, the non-significant p-value indicates that this correlation is not statistically significant, meaning that the observed relationship may be due to random chance.

Conversely, for the direction from Kuala Kangsar to Ipoh, the Pearson correlation coefficient is 0.279, with a two-tailed significance value of 0.435. This positive correlation suggests a weak direct relationship between non-compliance with road furniture and road accidents in this direction. Similar to the previous case, the non-significant p-value implies that this correlation is not statistically robust, and the observed relationship may be due to random variation. Overall, statistically, the results imply no correlation between non-compliance with road furniture and road accidents. There is no significance as the significance value is more significant than 0.05.

**Table 4** Correlation between Non-Compliance Road Furniture and Road Accident Occurrence

Direction	Result	
Ipoh to Kuala Kangsar	Pearson Correlation	-0.156
	Sig. (2-tailed)	0.666
	N	10
Kuala Kangsar to Ipoh	Pearson Correlation	0.279
	Sig. (2-tailed)	0.435
	N	10

Several factors could account for the weak correlation between both variables. This could be attributed to random fluctuations in the data, more intricate relationships not captured by straightforward analyses, or the influence of other factors, such as weather conditions or driver behaviors, which might significantly impact road accidents. Lastly, there is the possibility that the dataset is either insufficient in size or lacks diversity, limiting its ability to cover the full spectrum of potential relationships.

#### 4. Conclusion

In summary, the examination of road furniture along Road Section 606.85 to 607.85, from Ipoh to Kuala Kangsar and back, reveals a critical 37% non-compliance, demanding urgent attention. The study assesses visibility, legibility, and adherence to standards for traffic signs, signals, markings, kerbs, medians, and streetlights. Identified issues, such as broken signs and malfunctioning signals, pose substantial risks to road safety. Immediate corrective measures, including repairs and enhanced maintenance, are imperative to ensure safe roadways. Next, regarding the correlation between non-compliance road furniture and road accidents, weak correlations were found, and they are not statistically significant (p-values of 0.666 and 0.435). This implies no clear link between non-compliance and accidents, aligning with a MIROS (2017) study attributing 80% of accidents to human factors like speeding and distracted driving. Although environmental factors contribute minimally (13%), addressing deficiencies in road furniture is crucial for optimizing overall road safety and traffic efficiency. Highlighting the weak correlations emphasizes the predominant role of human behavior in road accidents, supporting the need for comprehensive measures to address both infrastructure and behavioral aspects. Behavioral aspect such as speeding, distracted driving, and failing to follow traffic restrictions all contribute to road accidents. These findings emphasise the necessity for a holistic strategy to road safety that includes both physical upgrades and behavioural interventions.

Future research should focus on the behavioural aspects of road users, namely the impact of driver attitudes, awareness, and adherence to traffic rules. Research on effective behavioural interventions, such as

public education campaigns, stricter law enforcement, and technical solutions (e.g., speed monitoring systems), could provide useful insights into lowering the number of car accidents. Policymakers can design more holistic traffic safety policies by combining behavioural studies and infrastructure upgrades.

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