

Examining Malaysian Road Users' Understanding of Visual Aids: Addressing Comprehension Gaps to Enhance Road Safety

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ABSTRACT – Traffic control devices, such as road signs and markings, are crucial for road safety, but their effectiveness relies on proper user comprehension. This study examines how Malaysian drivers comprehend traffic signs and road markings, with a focus on how driving experience influences interpretation. Based on 444 valid survey responses, the study found that 6.3% of participants had experienced crashes due to sign misinterpretation. While signs like “No Stopping” and “Obstruction” were well understood, critical signs such as “Stop,” “Give Way,” and “Advanced Warning Sign” showed poor recognition. Statistical analysis revealed that eight signs – particularly temporary and regulatory types like the “Detour Sign,” “Yellow Box,” and “Road Works Sign” – were significantly misunderstood by novice drivers, who were up to 2.7 times more likely to misinterpret them compared to experienced drivers. These findings highlight the need for targeted educational interventions, particularly for newer drivers. Visual learning tools, including infographics, social media campaigns, and refresher training, can help bridge knowledge gaps. Addressing high-risk groups and misunderstood signs can improve risk perception, reduce accidents, and enhance road safety. This study underscores the importance of continuous learning in fostering a safer driving culture.

KEYWORDS: Traffic control devices, road marking, traffic signs, traffic sign comprehension

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1. INTRODUCTION

Road safety depends greatly on the clarity and effectiveness of traffic control devices, especially visual aids such as road signs and markings. These elements communicate crucial information about road regulations, hazards, and directions, helping drivers make safe decisions. In Malaysia, such aids are regulated under ATJ 2A/85, 2C/85 (Pindaan 2017) and 2D/85 (Pindaan 2019), which classify them into regulatory, warning, guide, and temporary signs, as well as longitudinal and transverse markings (JKR, 2019). However, their effectiveness hinges not only on design standards but also on users' ability to interpret them correctly.

Despite standardized guidelines, many drivers struggle with visual aid comprehension. Misunderstandings often lead to traffic inefficiencies or accidents, particularly in complex or unfamiliar road settings. Abdul Manan et al. (2021) reported that nearly 28% of safety concerns on Malaysian non-expressway roads were linked to inadequate signage and markings. Ng and Chan (2011) found that cognitive learning methods – such as recall training, feedback, and associative techniques – can significantly improve sign recognition and retention, suggesting the value of education-based interventions.

Since more than 90% of driving-related information is visual (Hills, 1980; Sivak, 1996; Spence & Ho, 2015), any failure in visual attention can compromise safety. Research by Guo et al. (2010) showed that many crashes occur not due to slow responses, but because drivers fail to detect hazards at all. Similarly, Charlton and Starkey (2013) stressed that perceptual lapses are a major factor in traffic accidents, highlighting the need for intuitive and easily recognizable signage.

In addition, comprehension is shaped by cultural and individual factors. Malaysian drivers, for instance, have been shown to scan for different visual cues compared to their UK counterparts (Miller et al., 2021). Novice drivers often lack real-world exposure (Dewar et al., 1994; Shinar et al., 2003; Johansson & Backlund, 1970), while older drivers may face declining cognitive abilities. Environmental conditions further impact visibility, with innovations like luminescent markings proving helpful in low-light settings (Villa et al., 2023). However, Malaysia currently lacks tailored, experience-based training programs to address these comprehension gaps. This study investigates Malaysian drivers' understanding of visual aids to identify key challenges and recommend strategies for improved traffic safety.

2. METHODOLOGY

This study used a quantitative survey approach to assess Malaysian road users' understanding of traffic signs and road markings. The survey, distributed via Microsoft Forms, included 52 questions covering demographics, crash history related to sign misinterpretation, and comprehension of visual aids. It also featured images of common Malaysian traffic signs and markings, asking respondents to identify meanings and appropriate actions. Some questions allowed multiple correct answers based on context, helping to assess both knowledge and decision-making.

A total of 475 responses were collected, with 444 valid entries retained after removing incomplete and duplicate data. Most respondents were aged between 26 and 45 years and worked in the government or private sectors, with others being students or self-employed (Table 1). In terms of education, 75.5% held a diploma or bachelor's degree, while 11.1% held postgraduate degrees. Regarding driving experience, 34.2% had less than five years of car driving experience, and 45.7% had never ridden a motorcycle. These diverse backgrounds helped ensure a well-rounded analysis of comprehension across different user profiles.

TABLE 1: Demographic attributes of respondents

Demographic Aspect			Demographic Aspect		
Percentage (%)			Percentage (%)		
N = 444					
Gender	Male	43.5	Education	Matriculation	0.2
	Female	56.5	Level (cont'd.)	Secondary School	11.7
Age Group	16 – 20 years old	22.5		Primary School	0.9
	21 – 25 years old	12.2		Certificate / Diploma	32.9
	26 – 30 years old	9.9		Others	0.7
	31 – 35 years old	16.2	Motorcycle	Not Applicable	45.7
	36 – 40 years old	19.4	Riding	> 0 – 5 years	14.4
	41 – 45 years old	12.8	Experience	6 – 19 years	10.1
	46 – 50 years old	2.9		11 – 15 years	8.1
	51 – 55 years old	2.5		16 – 20 years	9.7
	>56 years old	1.6		21 – 25 years	5.2
Occupation	Self employed	2		26 – 30 years	4.7
	Government	28.3		>30 years	2
	Private	34.5	Car Driving	Not Applicable	14
	Student	28.1	Experience	> 0 – 5 years	34.2
	Not working	3.8		6 – 19 years	11.7
	P - hailing / e-hailing	3.3		11 – 15 years	14.4
Education	PhD	1.4		16 – 20 years	12.6
Level	Master's Degree	9.7		21 – 25 years	7.4
	Bachelor's Degree	42.6		26 – 30 years	2.7
				>30 years	2.9

3. RESULTS AND DISCUSSION

This section analyzes respondents' crash history and their understanding of traffic visual aids. It also looks at how driving experience affects the ability to interpret regulatory signs, warning signs, and road markings. The goal is to identify gaps in comprehension that may lead to unsafe driving, especially among novice drivers.

3.1 Crash History

As part of the survey, respondents were asked whether they had ever been involved in a crash resulting from confusion over road signs. A total of 28 individuals (6.3%) reported having experienced such an incident (see Figure 1). Among these cases, the majority were male (71.4%), while females accounted for 28.6%. Notably, 64.3% of those involved in these crashes indicated that they were driving a car at the time, suggesting that the misinterpretation of road signs poses a particular challenge for drivers. The reasons cited for these incidents varied but commonly included unclear or contradictory signage, misleading directions, collisions at intersections, inadequately marked work zones, insufficient warnings of restricted access, and other related issues – highlighting critical gaps in visual aid effectiveness.

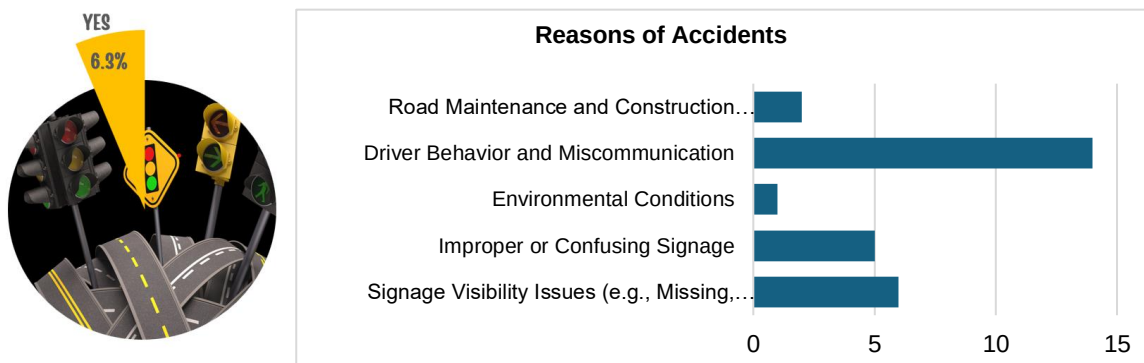


FIGURE 1: Summary of responses to B12, "Have you been involved in an accident due to confusion over road signs?"

3.2 Visual Aid Comprehension

Understanding traffic signs and road markings is vital for ensuring safe and organized road use, as these visual aids provide essential information – such as regulations, warnings, and directions – that guide the behavior of all road users, including drivers, motorcyclists, cyclists, and pedestrians. When properly interpreted, they promote consistent and predictable actions, reducing confusion and enhancing overall road safety. Survey results, as illustrated in Figure 2, revealed varying levels of comprehension among respondents. While signs like "No Stopping" (92.1%) and "Obstruction" (89.4%) were widely understood, key regulatory signs such as the "Stop" (10.4%) and "Give Way" (9.7%) had notably low recognition rates. Similarly, temporary signs like the "Advanced Warning Sign" (13.1%) and "Road Works Sign" (13.7%) were poorly interpreted. In contrast, signs like the "Detour" (64.9%), "Yellow Box" (79.7%), and "Turn Right or Go Straight" (76.4%) received moderate recognition. These results indicate the need for improved education and awareness to strengthen road users' understanding of traffic visual aids.

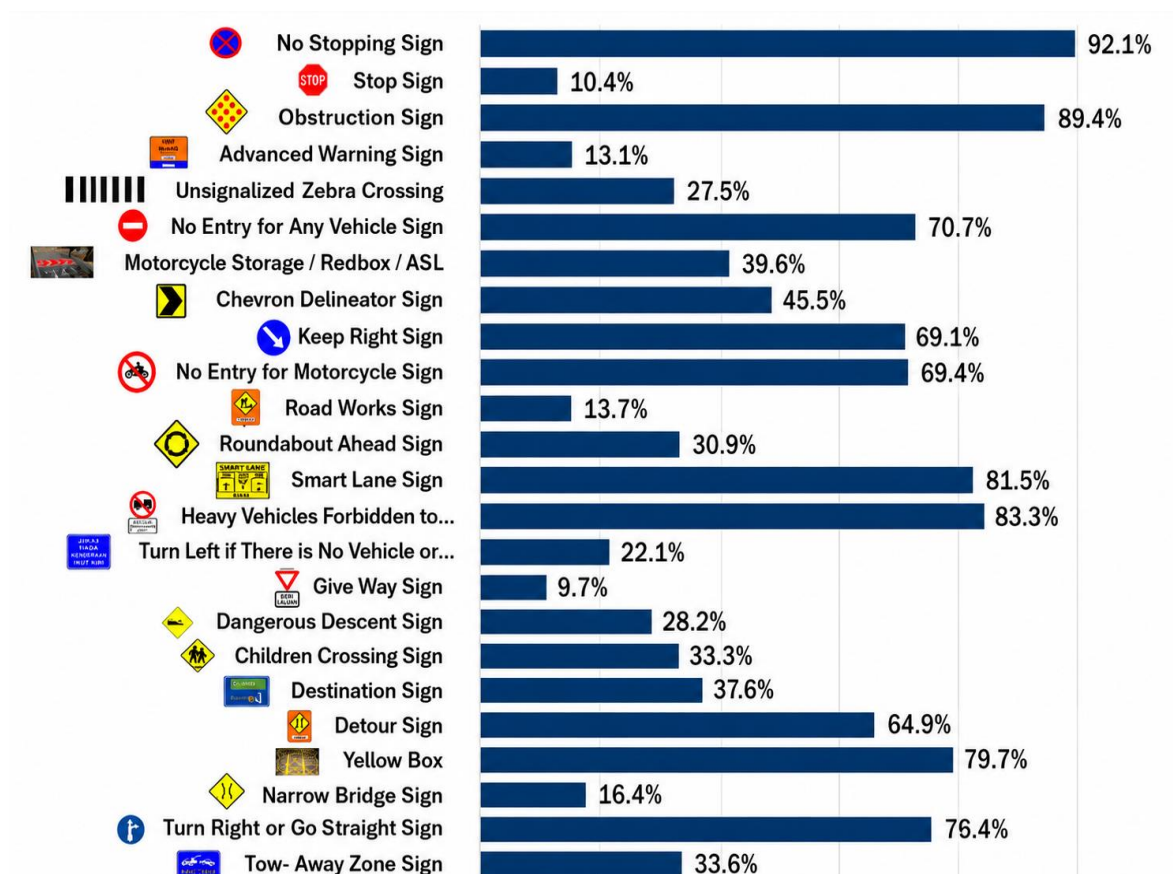


FIGURE 2: Percentage of correctly identified visual aids by respondents

3.3 Impact of Driving Experience on Visual Aids Comprehension

Driving experience significantly affects a driver's ability to interpret traffic signs and road markings accurately. Prior studies (Shinar et al., 2003) affirm that exposure to varied traffic situations over time enhances sign recognition and decision-making. In contrast, novice drivers—those with less than eight years of experience – typically rely on theoretical knowledge obtained from driving lessons, which may not equip them with the practical skills needed to interpret complex, conditional, or temporary signage (Dewar et al., 1994; Babić et al., 2017; Syafiq et al., 2021). This gap becomes evident in the misinterpretation of signs requiring situational awareness or fast responses. Supporting this, Charlton and Starkey (2013) noted that real-world exposure significantly improves sign comprehension. Supporting these findings, the present study assessed comprehension of 24 traffic signs among Malaysian drivers, with statistical tests revealing that eight (8) visual aids had a significant association with driving experience.

Based on the results presented in Table 2, the eight visual aids that have statistically significant associations with driving experience are Advanced Warning Sign (Q4), No Entry for Any Vehicle Sign (Q6), Keep Right Sign (Q9), Road Works Sign (Q11), Roundabout Ahead Sign (Q12), Detour Sign (Q20), Yellow Box (Q21), and Turn Right or Go Straight Sign (Q23).

In each case, novice drivers demonstrated a higher likelihood of misinterpreting the sign or marking compared to experienced drivers. These findings underscore the importance of targeted education strategies in early driver training to address gaps in comprehension. The following subsections provide a detailed analysis of the findings for each of these significant visual aids.

TABLE 2: Summary of odds ratio and significance level

No	Sign Description	p-value (95% CI)	O.R.	No	Sign Description	p-value (95% CI)	O.R.
Q1	Stopping Prohibited	0.795 (0.538 – 2.247)	1.099	Q13	Smart Lane Sign	0.066 (0.969 – 2.571)	1.578
Q2	Stop Sign	0.211 (0.363 – 1.253)	0.675	Q14	Heavy Vehicles Forbidden to Overtake Sign	0.790 (0.550 – 1.576)	0.931
Q3	Obstruction	0.147 (0.851 – 2.889)	1.568	Q15	Turn Left if There is No Vehicle or Pedestrian Sign	0.731 (0.677 – 1.744)	1.086
Q4	Advanced Warning Sign*	0.013 (1.170 – 4.449)	2.281	Q16	Give Way Sign	0.086 (0.905 – 3.945)	1.889
Q5	Unsignalized Zebra Crossing	0.112 (0.460 – 1.085)	0.707	Q17	Dangerous Descent Sign	0.386 (0.782 – 1.885)	1.214
Q6	No Entry for Any Vehicle Sign*	0.024 (1.063 – 2.466)	1.619	Q18	Children Crossing Sign	0.058 (0.448 – 1.014)	0.674
Q7	Motorcycle Storage / Redbox / ASL	0.813 (0.640 – 1.419)	0.953	Q19	Destination Sign	0.056 (0.455 – 1.010)	0.678
Q8	Chevron Delineator Sign	0.164 (0.892 – 1.961)	1.323	Q20	Detour Sign*	<0.001 (1.791 – 4.047)	2.692
Q9	Keep Right Sign*	0.003 (1.237 – 2.836)	1.873	Q21	Yellow Box*	<0.001 (1.448 – 3.713)	2.319
Q10	No Entry for Motorcycle Sign	0.120 (0.917 – 2.112)	1.392	Q22	Narrow Bridge Sign	0.369 (0.472 – 1.322)	0.790
Q11	Road Works Sign*	0.032 (1.052 – 3.721)	1.978	Q23	Turn Right or Go Straight Sign*	<0.001 (0.206 – 0.599)	0.351
Q12	Roundabout Ahead Sign*	0.006 (0.369 – 0.845)	0.558	Q24	Tow-Away Zone Sign	0.891 (0.644 – 1.467)	0.972

*The results are statistically significant at $p < 0.05$

Advanced Warning Sign (Q4)

The chi-square test indicated a significant association between driving experience and comprehension of the *Advanced Warning Sign* ($\chi^2 = 6.109$, $p = 0.013$). The odds ratio of **2.281** (95% CI: 1.170–4.449) suggests that novice drivers were approximately **2.3 times more** likely to **misinterpret** this warning sign than experienced drivers.

No Entry for Any Vehicle Sign (Q6)

A significant difference in comprehension of the *No Entry for Any Vehicle Sign* was observed between novice and experienced drivers ($\chi^2 = 5.087$, $p = 0.024$). The odds ratio was **1.619** (95% CI: 1.063–2.466), indicating that **novice drivers** were over **1.6 times more** likely to **misinterpret** this regulatory sign.

Keep Right Sign (Q9)

The chi-square result ($\chi^2 = 8.904$, $p = 0.003$) revealed a statistically significant relationship between driving experience and comprehension of the *Keep Right Sign*. The odds ratio was **1.873** (95% CI: 1.237–2.836), indicating that **novice drivers** were nearly **1.9 times more** likely to **misinterpret** this regulatory sign.

Road Works Sign (Q11)

Comprehension of the *Road Works Sign* also varied significantly by driving experience ($\chi^2 = 4.606$, $p = 0.032$). An odds ratio of **1.978** (95% CI: 1.052–3.721) suggests that **novice drivers** were nearly **twice as likely to misinterpret** this temporary warning sign.

Roundabout Ahead Sign (Q12)

A significant association was found between driving experience and comprehension of the *Roundabout Ahead Sign* ($\chi^2 = 7.666$, $p = .006$). The odds ratio was **0.558** (95% CI: 0.369–0.845), indicating that **novice drivers** were **less likely** to interpret the sign **correctly**. This inverse relationship signals a critical learning gap, given that roundabouts require rapid and confident decision-making.

Detour Sign (Q20)

The *Detour Sign* showed a highly significant association with driving experience ($\chi^2 = 23.318$, $p < 0.001$). The odds ratio of **2.692** (95% CI: 1.791–4.047) indicates that **novice drivers** were approximately **2.7 times** more likely to **misinterpret** this sign. These results emphasize that temporary situational signage, often encountered during diversions, may be particularly challenging for new drivers and should be addressed with scenario-based training.

Yellow Box (Q21)

A significant difference in comprehension of the *Yellow Box road marking* was found ($\chi^2 = 12.642$, $p < 0.001$). The odds ratio was **2.319** (95% CI: 1.448–3.713), suggesting that **novice drivers** were **more than twice** as likely to **misinterpret** this marking. These findings highlight the need for clearer instruction on surface markings during early stages of driver education, especially for rules related to intersection management.

Turn Right or Go Straight Sign (Q23)

The *Turn Right or Go Straight Sign* also showed a strong association with driving experience ($\chi^2 = 15.617$, $p < 0.001$). The odds ratio of **0.351** (95% CI: 0.206–0.599) reflects that **novice drivers** were significantly **less likely to correctly interpret** the sign, while **experienced drivers** were **nearly three times** more likely to do so.

4. CONCLUSION

This study provides strong evidence that driving experience significantly affects the comprehension of traffic signs and road markings. Out of the 24 visual aids tested, eight showed statistically significant differences in interpretation between novice and experienced drivers. Novice drivers were up to 2.7 times more likely to misinterpret signs such as the Detour Sign, Yellow Box, Advanced Warning Sign, and Turn Right or Go Straight. These signs often appear in temporary or complex situations requiring quick responses, which less experienced drivers may not be adequately prepared for.

These findings are consistent with previous research suggesting that real-world driving exposure enhances sign recognition and decision-making accuracy (Shinar et al., 2003; Al-Madani & Al-Janahi, 2002). Novice drivers, who typically rely on theoretical knowledge from licensing programs, may not have the situational experience needed to correctly interpret less familiar or condition-specific signage (Dewar et al., 1994; Babic et al., 2017). Furthermore, signs involving regulatory or temporary instructions – such as roadworks or roundabout warnings – were particularly prone to misinterpretation, echoing the results of Charlton and Starkey (2013) on the importance of repeated exposure.

In response to these insights, it is recommended that driver education programs be enhanced to include practical, scenario-based training. This should involve visual simulations, real-world case examples, and focused instruction on signs frequently misunderstood by novice drivers. Such targeted interventions can help bridge the gap between classroom learning and real-life application. In addition, policymakers and road safety authorities should consider implementing refresher courses or public awareness campaigns to reinforce visual aid comprehension among all drivers. Addressing these

deficiencies early may substantially improve driver decision-making and reduce the risk of preventable crashes – particularly in high-risk or rapidly changing traffic environments. Building on this, future studies that analyze crash history relative to driving experience will be crucial for developing even more targeted interventions.

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