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Research Article

Effects of Different Seatbelt Reminders on Seatbelt Wearing Rates: Malaysian Case Study

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Abstract

This study examines the degree to which seatbelt reminder devices work to encourage car occupants across multiple seating positions to use seatbelts. Three vehicle conditions were tested using a within- and between-subject experimental design, including visual reminder only (Perodua Myvi), intermittent reminder (Hyundai Creta), and incessant warning (Perodua Ativa). Participants completed pre and post experiment questionnaires and were observed across different laps while driving or riding in selected vehicles. A total of 35 participants completed the on-road experiment involving three seatbelt reminder configurations: visual reminder only, intermittent auditory reminder, and incessant auditory reminder. The results showed no statistically significant differences in seatbelt wearing rates among the reminder conditions across the evaluated seating positions ($p > 0.05$). Nevertheless, enhanced reminder systems demonstrated a tendency toward higher seatbelt compliance than visual-only reminders. The findings suggest that participant selection based on self-reported behaviour and the relatively small sample size may have limited the statistical sensitivity of the experiment.

Keywords: Seatbelt reminders; Malaysian driver; Seatbelt wearing rate

The Technology Readiness Level (TRL) of this research is Level 5 (Technology Validated in a Relevant Environment). This study assessed commercially available seatbelt reminder systems through controlled on-road experiments using multiple vehicle models and seating positions under realistic driving conditions. The findings provide experimental evidence on how different reminder configurations influence seatbelt wearing behaviour. Further large-scale validation with more diverse participants, vehicle types, and real-world traffic conditions is needed before broader implementation or policy recommendations can be supported.

1. Introduction

Even though seatbelt is one of the vehicle's safety measures that may save lives, compliance remains a challenge, particularly in Malaysia. The Seatbelt Reminder System (SBR) is designed to improve the use of seatbelts among individuals. The current belt reminder mandated by the National Highway Traffic Safety Administration (NHTSA) has not successfully encouraged belt usage [1]. This demonstrates the need for a well-designed seatbelt reminder to enable drivers and passengers to buckle up while driving. However, the existing seatbelt reminders have not solved the problem. Automakers have devised various reminders with a combination of visual and auditory aids that aim to alert the driver and passenger. The use of seatbelts is still not improved by the numerous reminders included as safety features, such as chime sounds, loud and clear sounds, intermittent sounds, and more [2]. Most manufacturers use an intermittent chime that lasts for a few seconds. Although this system's contribution to belt usage has not been systematically assessed, it is not generally regarded as an effective inducer of belt use. The reason for this statement is that the reminders are not persistent enough to encourage them to buckle up their seatbelt. These differences indicate a knowledge gap on whether SBR setups best promote seatbelt use under various driving circumstances and behaviours.

A study by [3] stated that it is unclear what trade-off in discomfort is acceptable and how potent a reminder is to get the remaining part-time belt users and non-users to utilize the belt more frequently. It is currently unclear which of the following parameters, incessant warning, intermittent warning, and auditory volume, is most successful in getting people to buckle up. Similarly, while louder and higher-pitched sounds may attract drivers' attention, they may also be less acceptable to the general population due to their perceived annoyance [4]. Lie *et al*. [5] explored seatbelt usage recognition systems advancements and highlighted the challenges in improving compliance by detecting improper usage and persistent reminders. This highlighted the gap between different reminder parameters, such as volume and duration, which can affect people's opinions and acceptance. One recent example is Ford's Beltminder™, which consists of a warning tone with a moderate loudness level and a flashing light on the dashboard that stays on until the seatbelt is buckled [6]. The reminder to use a seatbelt includes these characteristics: alarm loudness, audible frequencies, and continuous or intermittent warnings. Lie *et al*. [5] examined this kind of reminder and revealed that they significantly impacted seatbelt use in Sweden. In automobiles without seatbelt warnings, 82.3 % of passengers used seatbelts. The seatbelt usage rate for vehicles with seatbelt warnings was 98.9 %.

Research has widely stated that using seatbelts continuously supports and helps reduce the severity of injuries, especially for passengers in the rear seat. Wearing seat belts is well established to lessen the degree of injuries sustained by car occupants in collisions, and several studies have demonstrated how beneficial seat belt use is for passengers in the backseat [7]. This is to ensure that all passengers in the car are shielded from the significant danger of harm and death brought on by traffic accidents. People think occupants at the back might be safe from facing the high risk of injury and fatalities due to the distance being further from the dashboard and windshield. The unstrained occupant on the rear seat also has a high potential to be thrown forward due to force and inertia during the crash, and this can lead them to face consequences such as injury to the upper body, especially the head. The use of 3-point or shoulder seatbelts can significantly improve passenger safety. It was found that rear seat lap/shoulder belts are 25% more effective than lap belts alone at reducing deaths and that the switch from lap to lap/shoulder belts has greatly improved rear seat occupant safety in frontal accidents [8]. A study explored the optimization of occupant restraint systems using machine learning techniques, demonstrating improvements in reducing injury risks by enhancing the design and validation of crash safety features [9]. It is vital to activate the advanced seatbelt system to ensure that safety can be secure, but the occupant must buckle up. To increase the occupant's buckle-up rate while driving, the seatbelt reminder (SBR) is one of the methods used or employed to influence them to use seatbelts as user safety precautions. A study investigated the design of reminder systems integrated into highly automated vehicle interfaces to support individuals with mild cognitive impairments, emphasizing the importance of system-initiated prompts for safety and compliance [10].

Even though many reminders have been implemented, people still ignore the auditory and visual warnings that encourage them to buckle up. A study by Howell stated that sound from radio and infotainment systems can erase the reminder audio and make them forget to buckle up while driving [1]. Many motorists do not buckle up until sometime after starting their vehicles. According to General Motors' survey data, 70% of drivers report various reasons for this behaviour. They often ignore the seatbelt chime, fail to hear it over the radio, or forget about it when backing out of the driveway. Many drivers suggest they need a more pungent reminder to buckle up [11]. Given this challenge, there is a need to systematically investigate the effectiveness of various seatbelt reminder parameters that can influence people to buckle up while driving [12]. Based on the identified research gap, this study aims to evaluate the effectiveness of three different seatbelt reminder systems, namely visual reminder only, intermittent auditory reminder, and incessant auditory reminder, in influencing seatbelt wearing behaviour among Malaysian vehicle occupants. The study also compares seatbelt compliance across three seating positions, namely the driver, front passenger, and rear passenger. It is expected that reminder systems incorporating persistent auditory warnings would promote higher seatbelt wearing rates than visual reminders alone, thereby providing useful evidence for improving occupant safety systems.

1.1. Auditory Reminders

The auditory warning has become critical for assisting and notifying the driver and passenger to buckle up before beginning the journey. These audio cues are designed to capture the occupant's attention and respond to the seatbelt reminder system. The auditory tone is a crucial factor in the efficiency of a reminder [4]. Recent research emphasizes that well-designed auditory reminders significantly improve seatbelt compliance, especially when persistent auditory signals are implemented [4]. **Table 1** shows that, depending on the nations and organizations that assess the vehicle, there are several types and standards for auditory warnings. As previously stated, the threshold for a reminder in the United States is at least four (4) seconds but no more than eight (8) seconds. This short but noticeable reminder is intended to prompt the occupant to buckle up as soon as possible once they start to drive. However, a separate regulation has been imposed in Europe to promote seatbelt use.

Table 1. Standard requirements of audio reminder globally

Audible Reminder							
Body	Seating Row	Min. duration (sec)	Max. allowed separation between signals	Start requirement			Notes
				Distance (m)	Velocity (km/h)	Duration	
ASEAN NCAP	1st	90	25	500	25	60	After ignition/forward motion/following change in buckle status
CHINA NCAP	1st	1st level: 30	1st level: 10	500	25	60	After ignition
		2nd level: 90	2nd level: 10	1000	40	90	After ignition/forward motion/after 1st level
EURO NCAP	1st	1st level: 30	1st level: 10	500	25	60	After ignition
		2nd level: 90	2nd level: 10	1000	40	90	After ignition/forward motion/30 seconds after 1st level change in buckle status
GLOBAL NCAP	1st	90	25	500	25	60	After ignition/forward motion
IIHS	1st	90	3	Within 30 seconds when speed between 10 and 40 km/h and within 2 seconds when speed greater than 40 km/h			Frequency: at least 1 dominant frequency 500-2250 Hz
							Volume: ≥ 6dB above ambient noise

The Euro New Car Assessment Program (Euro NCAP) has praised automobiles with seatbelt reminders (Euro New Car Assessment Programme, 2023). It set a standard with two (2) different levels. On level one (1), the reminder will signal for 30 seconds, followed by 90 seconds for level 2 [3]. China NCAP has also implemented this standard requirement. The Insurance Institute for Highway Safety (IIHS) has a similar requirement but includes detailed reminder requirements: volume and frequency. IIHS sets the frequency between 500 Hz and 2250 Hz, and the volume must be higher than 6 dB [3].

A strong and clear light and sound signal must be operational for at least 90 seconds if the seatbelt is not used [5]. Recent advancements highlight the importance of longer-duration reminders for increasing compliance, as persistent signals result in higher adherence rates than short-duration alerts [5]. This approach by Euro NCAP enhances the reminder with an extended duration and influences the driver to comply as soon as the reminder starts. It demonstrates that even the most effective reminder may be called into doubt. The shorter reminder may be less annoying to users but cannot influence them to comply and buckle up fully. While the more extended and louder reminders with high frequency and volume may have many compliances, they might become annoying to the occupant. An adequate audio warning should be set at a specified level and frequency to encourage seatbelt usage. A study by [14] stated that, as a result, it is vital to select the most effective car technology for encouraging seatbelt use and identify one that customers would embrace. An overly aggressive and too intense reminder may lead the users to find a way to deactivate it, eliminating the reminder's function. Alerts. Lie *et al.* [5] introduced a robust framework for detecting seatbelt misuse cases and incorrect usage using a combination of local prediction, global assembly, and shape modelling, enhancing the reliability of seatbelt detection systems in driver monitoring applications. Setting the auditory at the right volume and frequency is essential to ensure that user compliance can increase periodically.

1.2. Visual Reminders

Visual warnings have become the first indicator motorists can use to fasten their seatbelts while driving. These visual indicators are the first line of promoting the seatbelt reminder system to the people. Some continuous or flashing visual displays indicate a motorist is not utilizing a seatbelt at the ignition [14]. Research highlights that modern visual reminders significantly increase situational awareness and improve compliance, especially with auditory signals [15]. In modern vehicle systems, advanced sensors ensure visual reminders are equipped for all seating positions, enhancing rear and third-row passenger compliance [16]. This sensor is fitted and placed under the seat of the vehicle. The system will send the information to the Electronic Control Unit (ECU). Once the ECU processes the data, the system will indicate and switch on the visual reminder. Automakers have developed many types of seatbelt visual reminders. **Figure 1** below shows three (3) different locations of visual reminders that the manufacturer has equipped.

Figure 1a shows a typical regular visual reminder placed on the driver's instrument panel. In contrast, for **Figure 1b**, the centre location before the rearview mirror becomes one of the locations for visual seatbelt reminders. This location is usually used by automakers in Europe. **Figure 1c** is one of the locations that automakers, especially Tesla, have introduced. It would remind users to buckle up through the centre infotainment. If the driver's seatbelt buckles sensor shows that the belt is unbuckled, the system informs the driver via an indication on the instrument panel. Kidd and O'Malley reviewed enhanced seatbelt reminder systems, finding that persistent, multimodal reminders that integrate auditory signals with visual cues increase seatbelt usage and can save approximately 1,600 lives annually by boosting compliance rates [4]. It cannot be decided which visuals might be the most effective way to influence people to use their seatbelts.

(c)

Figure 1. Example of the location of a visual reminder: (a) At the meter cluster; (b) at the front of the rear-view mirror; (c) At the infotainment console

2. Material and Methods

Figure 2 shows three (3) repeated laps with different tasks, covering a total distance of 2.20 kilometers: the black circle icon with the number one (1) represents the path in the first lap, and lap one was used for participant familiarization. For lap 2, the black circle icon with the number two (2) indicates the path tested on lap 2. The task on lap two (2) is to remove a box from the vehicle's trunk in the middle of the track, as shown in **Figure 2**. For the last lap, lap 3, the black circle icon with the number three (3) represents the path for lap 3, with the task of placing a water bottle into the vehicle's cabin. Three (3) different types of cars, Perodua Ativa, Hyundai Creta, and Perodua Myvi, were used in this study.

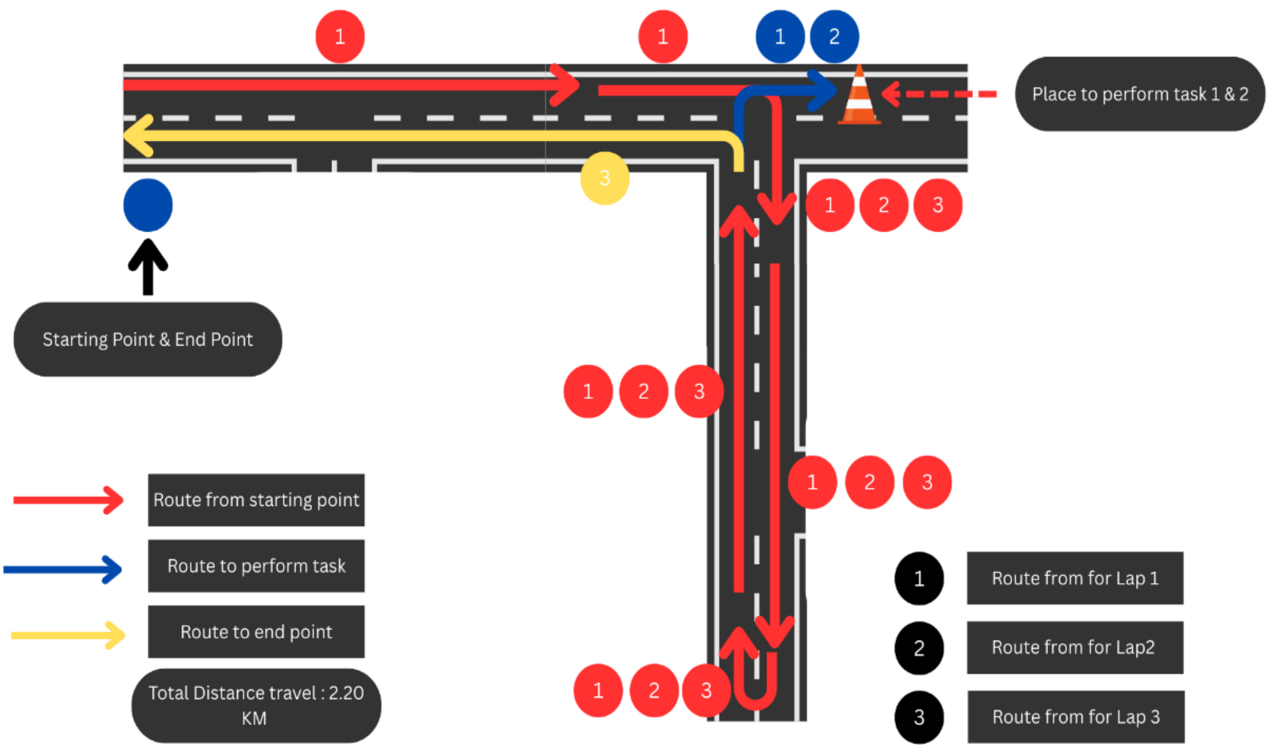

Figure 2. Route used in this study

2.1. Participants and Tested Vehicles

A pre-experiment was conducted to select the appropriate participants for this study. This study required participants who used seatbelts part-time to join the experiment, testing how different seatbelt reminders can influence them to buckle up. The total number of respondents gathered is 237. Two (2) main questions being used as indicators for the selection of participants. From 237 respondents, the researcher filtered the responses and found only 60 potential part-time seatbelt users based on the selected questions. Participants who answer "yes" or "maybe" were selected as the participants for this study. For the dummy clip question; 37 participants (15.6%) answered 'yes,' and 14 participants (5.9%) answered 'maybe'. The secons question, 24.5 % (58 participants) answered 'yes', and 8 % (19 participants) answered 'maybe'. This question served as the baseline for participant selection. Of the 60 participants selected, only 35 were willing to join the study. They have been informed via group and personal messages regarding the experiment. Even though personal interaction has been used to invite all 60 participants to join, they show no intention of joining. In the end, only 35 of the participants booked their slots for the experiment session. The participant selection procedure was based on self-reported responses because direct observation of participants' habitual seatbelt use prior to the experiment was not practically feasible. Although this screening approach has been widely adopted in behavioural studies, self-reported behaviour may not always accurately represent actual driving practices due to behavioural inconsistency and self-selection bias [17]. Therefore, this limitation was considered during the interpretation of the experimental findings.

Although three different vehicle models were used, the experiment was designed to minimize potential confounding effects by selecting commercially available vehicles with comparable passenger vehicle characteristics, including automatic transmission, similar seating configurations, and standard passenger cabin layouts. The primary distinction among the selected vehicles was the seatbelt reminder configuration, which constituted the principal variable investigated in this study. Furthermore, all experimental sessions were conducted on the same test route and under similar environmental conditions to reduce external variability.

In this study, three (3) types of vehicles were used: Perodua Ativa, Hyundai Creta, and Perodua Myvi (2nd Generation), based on their reminders system (see **Table 2**). The Perodua Myvi, launched in 2021, has a standard seatbelt reminder system that only features visual seatbelt reminders, reminding users to buckle up. The second vehicle, the Hyundai Creta, features an enhanced seatbelt reminder that comes with the intermittent feature. It has a 90-second reminder to prompt the driver and front passenger to use their seatbelts. The third vehicle, the Perodua Ativa, has the same features as the Hyundai Creta but with a different seatbelt reminder. It is equipped with a seatbelt reminder that starts to sound slowly for the first 30 seconds but becomes more aggressive after 30 seconds of the journey or known as incessant warning.

The final sample consisted of 35 participants, representing all eligible volunteers who agreed to participate after the screening process. Although the sample size was relatively limited, it is comparable to those commonly reported in exploratory behavioural and human-factor experiments involving controlled on-road evaluations. Therefore, the findings should be interpreted as preliminary evidence, providing valuable insights for designing larger-scale studies with greater statistical power.

Table 2. Seatbelt Reminder System (SBR) for each of the tested vehicles

Vehicle	Technology	Seatbelt reminder (SBR)	
		Visual Reminder	Audio Reminder
Perodua Myvi	Standard seatbelt reminder	- Visual Reminder only (keep blinking without audio) - Only driver	None
Hyundai Creta	Enhanced seatbelt reminder	- Visual Reminder - For driver and front passenger	- Intermittent Reminder (sounding for 90 second with constant volume and frequency) - Only driver and front passenger - First Volume with Max A/C (67.6 dB) - Second Volume with Max A/C + SBR (70.4 dB)
Perodua Ativa	Enhanced seatbelt reminder	- Visual Reminder - For driver, front passenger and rear passenger	- Incessant Reminder (sounding for 30 second and start to sound more aggressive) - Applicable for all seating position - First Volume with Max A/C (66.8 dB) - Second Volume with Max A/C + SBR (69.6 dB) - Second Volume with Max A/C + SBR (72.0 dB)

2.2. Overview of the Study

This study tested the three (3) Conditions of the Seatbelt Reminder (SBR) system, and the participant was assigned a position either as Driver, Front Passenger, or Rear Passenger. Participants were randomly assigned to one of the seating positions (driver, front passenger, or rear passenger) using a simple random allocation procedure prior to the experiment. Within each seating position, participants were subsequently assigned to the corresponding experimental conditions to ensure balanced group allocation while minimizing allocation bias. In total, three (3) experiments were conducted with two (2) different measurements on each experiment. To ensure the experiment runs smoothly, codes were used to represent the participants in this experiment. For a Driver with Condition 1, the code is N_{C1_D}, and for a driver with Condition 2, the code is N_{C2_D} , and for Condition 3, the Driver is N_{C3_D}. For the front passenger on Condition 2, the code is N_{C2_FP} , and Condition 3 for the front passenger is N_{C3_FP}. For the rear passenger N_{C1_RP}, it is used as a code for the rear passenger in Condition 1, N_{C2_RP}, it is for Condition 2 N_{C3_RP}, it is for Condition 3. **Figure 3** shows the experimental design employed to investigate the effects of various seatbelt reminders. The total number of participants is 35, N_{Total} involved in this study.

Figure 3 summarizes the experimental workflow. Participants were first randomly allocated to one of the three seating positions (driver, front passenger, or rear passenger). Each seating position was subsequently evaluated under the corresponding seatbelt reminder conditions according to the availability of reminder functions in each vehicle model. Every participant completed only the assigned experimental condition to eliminate carry-over effects and maintain independent observations between groups.

For the Driver position, the number of participants N_{Total_Driver} is 21. Condition 1 used a Perodua Myvi 2012, which was only equipped with a visual reminder. The participants drove the Perodua Myvi, and the only visual reminder was a prompt to buckle up. On Condition 2, the Hyundai Creta would remind the user of audible and visual warnings. The third vehicle, Perodua Ativa, was used in this experiment for Condition 3. Perodua Ativa has the same reminder system but with incessant reminders that become more aggressive when users still do not buckle up. The red circle in **Figure 3** represents the seating position of participants during the experiment.

In the other seating position, which is Front Passenger, the Conditions that were tested were only two (2). The Perodua Myvi was excluded from this seating position because the visual reminder was limited to the driver. The Hyundai Creta was used because it is equipped with an audible reminder that can be heard by the passenger, even though the visual reminder cannot be seen. The Perodua Ativa was also used in this seating position, accompanied by an audible reminder, which was an incessant one. Each of these Conditions were tested by seven (7) participants, ensuring a balanced comparison across vehicle types and reminder systems. For the Rear Passenger, the Condition remains the same as the Front Passenger setup. The Hyundai Creta and Perodua Ativa were used in this position with the same number of participants involved. The diagram also visually indicates the seating position associated with each Condition, helping to clarify the structure and distribution of the experimental setup.

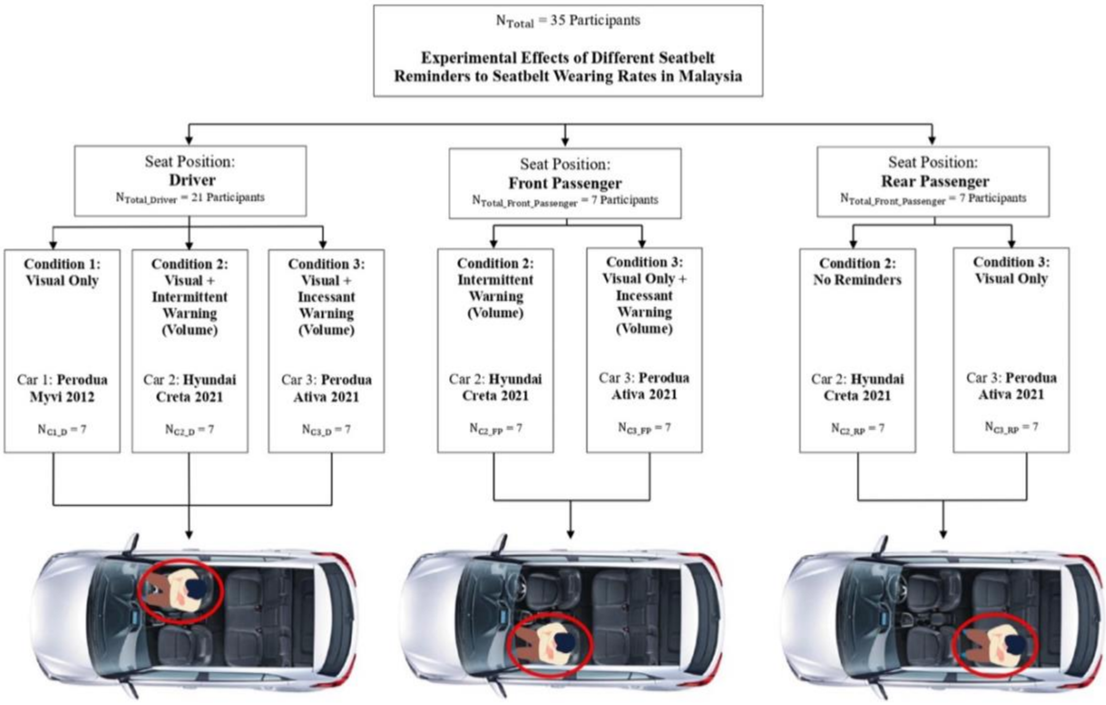

Figure 3. Overview of experiment arrangement with different seat locations

2.3. Procedure

In this experiment, each session took ten (10) minutes to complete for one (1) participant. A study procedure and protocol were reviewed and approved by the proper authority (MIROS) to ensure that all the safety aspects are not neglected. Each participant did the three (3) laps of the experiment, and each lap was provided with a different type of task to be performed. On the first lap, participants were allowed to perform a single lap to familiarize themselves with the conditions and circumstances of the track. The research team did not provide any instructions regarding seatbelt use at all. Participants performed another two (2) laps with the different tasks without any warning regarding seatbelts from the research team. On the second lap, the participant drove on the same track, but this time, the participant had to do the task before completing the single lap. The task assigned on the second lap was unbelted task 1 (taking out a box from the vehicle's trunk). Participants drove or rode until the target distance and then stopped to perform the task. After completing the task, participants completed the lap until the finish point. In this lap, the time to buckle back was taken to evaluate the users' response to the seatbelt reminder system (SBR). On the third lap, the participant again drove or rode the vehicle on a single lap and performed the unbelted task 2 (taking a water bottle into the vehicle's cabin). After completing the task, the participant continued the journey and ended the experiment session.

3. Results and Discussion

3.1. Seat Position: Driver

After the experiment session ended, data were gathered from the experiment equipment. The wearing rate of seatbelt usage for all conditions and seating positions was collected to analyze the wearing rate among participants. The wearing rate is one of the important parameters to evaluate the effectiveness of the seatbelt reminder system among three (3) conditions that were tested in this experiment. The outcomes were represented by the graph below, which shows that the tick sign (✓) indicates that the participant wore their seatbelt during the experiment. The (✕)

indicates that participants were not wearing their seatbelts during the experiment. The outcome of this experiment is one of the key findings of this study.

Twenty-one participants were randomly assigned to either Condition 1 (Perodua Myvi), Condition 2 (Hyundai Creta), or Condition 3 (Perodua Ativa), with seven (7) participants in each intervention (see Table 3). Lap 1, all Conditions shows the results with five (5) participants (71.4%) having used their seatbelt compared to two (2) participants (28.6%) who were not. There were no significant differences in the proportions of participants wearing rates in these three (3) interventions, p = 1.000. In lap 2, the conclusion of the wearing rates for all conditions showed that 4 participants (57.1%) had not used their seatbelts in Condition 1, compared to 2 participants (28.6%) in Conditions 2 and 3. There were no significant differences in the proportions of participants wearing rates in these three Conditions, p = 0.446 (see Table 3). At the end of the experiment, in lap 3, the conclusion of the seatbelt wearing rates for seating position: driver, six (6) participants (85.7%) had improved their seatbelt usage on Condition 3 compared to five (5) participants (71.4%) in the Condition 2 and three (3) participant's (42.9%) in the seatbelt wearing rates study. There were no significant differences in the proportions of participants wearing rates in these three interventions, p = 0.223. The three independent binomial proportions were not statistically significantly different (p > .05). The results for laps 1, 2, and 3 show that there is no significant difference on each lap, so the null hypothesis needs to be retained. This highlighted that the wearing rates between the three (3) Conditions are not different.

The absence of statistically significant differences among the three reminder conditions suggests that participant characteristics may have influenced the experimental outcomes. Although participants were selected based on self-reported responses indicating occasional seatbelt non-use, many participants consistently wore their seatbelts throughout the experiment. This discrepancy suggests that the participant selection procedure may have reduced the ability of the experiment to detect behavioural differences attributable to the reminder systems. Similar concerns regarding self-selection bias in behavioural studies have been highlighted by Stone *et al.* [17]. The absence of statistically significant differences among the three reminder conditions suggests that participant characteristics may have influenced the experimental outcomes. Although participants were selected based on self-reported responses indicating occasional seatbelt non-use, many participants consistently wore their seatbelts throughout the experiment. This discrepancy suggests that the participant selection procedure may have reduced the ability of the experiment to detect behavioural differences attributable to the reminder systems. Similar concerns regarding self-selection bias in behavioural studies have been highlighted by Stone *et al.* [17].

Table 3. Seatbelt Wearing Rates analysis on seating position: Driver

Lap	Condition	Wearing Types	Percentage	CSTOH
1	1	Yes	71.4 %	z = 0.000, p = 1.000
		No	28.6 %	
	2	Yes	71.4 %	
		No	28.6 %	
	3	Yes	71.4 %	
		No	28.6 %	
2	1	Yes	42.9 %	z = 1.615, p = 0.446
		No	57.1 %	
	2	Yes	71.4 %	
		No	28.6 %	
	3	Yes	71.4 %	
		No	28.6 %	
3	1	Yes	42.9 %	z = 3.000, p = 0.223
		No	57.1 %	
	2	Yes	71.4 %	
		No	28.6 %	
	3	Yes	85.7 %	
		No	14.3 %	

3.2. Seat Position: Front Passenger

On the front passenger seating position, two (2) Conditions were tested. By using the McNemar statistical test, the study wants to determine if there is any significant difference between the two (2) conditions. Seven (7) participants were recruited to take part in a seatbelt-wearing rate study based on two (2) Conditions. For recruitment, half of the participants were divided into Conditions 2 and 3. Following the intervention, the number of non-seatbelt users had maintained to 2 participants (28.57 %) for Condition 2, and only one (1) participant (14.29 %) did not use their seatbelt for Condition 3. This change was a consequence of two (2) different seatbelt reminder systems being tested. An exact McNemar's test determined that the difference in the proportion of wearing rates for Condition 2 and Condition 3 was not statistically significant, $p = 1.000$ (see **Table 4**).

On the other hand, for the Front Passenger seating position result, it has clearly been stated that the p-value of the analysis is 1.000, which means there is no significant difference between the two (2) Conditions that have been tested. It emphasises that this seating position makes no difference for this reason. The reason is due to the pre-experimental questionnaire. The pre-experiment questionnaire asked about the participant's behaviour and details regarding seatbelt usage. This makes participants envision what the experiment will be like if they are chosen. A study by Zou *et al*. [19], highlighted that, in the context of driving simulations, studies have noted that even basic pre-task exposure to questions about safety features, such as seatbelt reminders, can lead to a generalised compliance effect across experimental Conditions, masking the specific impact of different interventions.

One possible explanation is that the pre-experiment questionnaire may have increased participants' awareness of seatbelt use before the experiment. However, this interpretation should be considered cautiously because the present study did not directly evaluate the priming effect. Previous behavioural studies have reported that participants may modify their behaviour when they become aware of the study objective, a phenomenon commonly referred to as demand characteristics [20]. Therefore, the potential influence of participant priming cannot be excluded but should not be regarded as the sole explanation for the observed findings. It has also been discussed previously how it influences behaviour. It forced the participants to wear seatbelts even though the briefing session stated that the experiment wanted to test the comfort level for each Condition. This type of "priming" effect is a well-documented phenomenon in behavioural research, where participants adjust their behaviour due to cues that reveal the study's purpose, known as demand characteristics [20]. It indicates that the pre-experiment can influence the participants' perception towards the experiment.

Table 4. Seatbelt Wearing Rates for seating position: Front Passenger

Lap	Condition	Wearing Types	Percentage	McNemar Test
1	2	Yes	71.43 %	z = 0.000, p = 1.000
		No	28.57 %	
	3	Yes	85.71 %	
		No	14.29 %	
2	2	Yes	71.43 %	
		No	28.57 %	
	3	Yes	85.71 %	
		No	14.29 %	
3	2	Yes	71.43 %	
		No	28.57 %	
	3	Yes	85.71 %	
		No	14.29 %	

3.3. Seat Position: Rear Passenger

A study on the rate of seatbelt use based on two (2) Conditions was conducted with seven (7) participants, as illustrated in **Table 5**. Five participants (71.43%) in Condition 2 and the same number of participants (71.43%) in Condition 3 were non-seatbelt users after the intervention. **Table 5** shows that there are no appreciable differences between the two Conditions. According to a McNemar test, there was no statistically significant difference between Condition 2 and Condition 3 in terms of the proportion of wearing rates ($p = 1.000$).

The results show there is no significant difference between these two (2) Conditions when the experiment is being held. Even though there is no significant difference between each condition, it can be seen clearly that the percentage of seatbelt usage is very low, where only two (2) participants (28.57 %) wear their seatbelt when sitting on the rear passenger seat. One likely explanation that can be added to this discussion is that of the seatbelt reminders themselves. As mentioned, the rear passenger seatbelt reminders only depend on the visual seatbelt reminder for Condition 3.

Table 5. Seatbelt Wearing Rates for seating position: Rear Passenger

Lap	Condition	Wearing Types	Percentage	McNemar Test
1	2	Yes	28.57 %	z = 0.000, p = 1.000
		No	71.43 %	
	3	Yes	28.57 %	
		No	71.43 %	
2	2	Yes	28.57 %	
		No	71.43 %	
	3	Yes	28.57 %	
		No	71.43 %	
3	2	Yes	28.57 %	
		No	71.43 %	
	3	Yes	28.57 %	
		No	71.43 %	

The visual reminder on Condition 3, which is Perodua Ativa, is located above the rearview mirror, as shown in **Figure 1b**. This poor visibility may have rendered the remainder ineffective, which aligns with previous findings that show low effectiveness of visual-only reminders when not accompanied by persistent auditory cues or better visual positioning [4]. This shows that the location of the visual reminders is critical to ensure the passenger can notice the reminder and buckle up as soon as they see the reminders. The seatbelt reminder for rear passengers can be enhanced with the addition of a weight sensor to detect the presence of a passenger. This will help notify both the driver and the passenger to fasten their seatbelts. Reminders that rely solely on visual displays, especially when they are not in the occupant's field of view, are often ignored or missed entirely [19].

Although no statistically significant differences were identified, the observed trend suggests that enhanced reminder systems incorporating persistent auditory warnings may improve seatbelt compliance compared with visual reminders alone. This finding is generally consistent with previous studies by Lie *et al*. [5] and Kidd and Singer [13], who reported that persistent reminder systems were associated with increased seatbelt use among inconsistent seatbelt users. The absence of statistical significance in the present study is therefore more likely related to participant characteristics and sample size rather than indicating that reminder systems are ineffective.

4. Conclusion

The Seatbelt Reminder System (SBR) has been widely used in modern vehicles as a compulsory safety standard. It highlighted the importance of those reminders to ensure that the driver and passenger in all seating positions use their seatbelts. The effect of various levels of seatbelt warnings, as observed in an on-road study, has been analysed and discussed. The location and volume of seatbelt reminders become factors that can influence users to buckle up. The visual-only, visual with intermittent audio, and visual with incessant audio conditions in this study have shown no significant effect. This happened due to a few reasons, such as a small sample size, the ineffective selection of participants, and a few more, as mentioned in the discussion. Additionally, the optimum volume of seatbelt warnings that would help the seatbelt-wearing rates also showed no significant difference between the Conditions. Although statistically significant differences were not observed among the evaluated reminder systems, the findings indicate that reminder configurations incorporating persistent auditory warnings show potential for improving seatbelt wearing behaviour. These findings provide useful information for vehicle manufacturers in developing more effective occupant reminder systems that encourage seatbelt compliance across different seating positions. Furthermore, the results may assist road safety agencies in supporting future regulations and public safety initiatives aimed at increasing seatbelt usage. Future studies involving larger participant populations and more rigorous participant screening methods are recommended to further validate the effectiveness of advanced seatbelt reminder technologies.

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Conflict of Interest - The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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