Journal of Information Systems Engineering and Management
2025, 10(28s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Analysing Driver Memory for Safety Belt Messages on Variable Message Signs (Study Case: Arterial Road in Leeds)

Muhammad Riharizky Ananda [1], Samantha L. Jamson [2], Martha Leni Siregar [3*], Adil Afrizal [4]
[1] *Department of Civil and Environmental Engineering, Faculty of Engineering, University of Indonesia, Depok, Indonesia*
[2] *Scholar, Department of Transport Studies, Faculty of Environment, University of Leeds, Leeds, United Kingdom*
[3] *Scholar, Department of Civil and Environmental Engineering, Faculty of Engineering, University of Indonesia, Depok, Indonesia*
[4] *Department of Civil and Environmental Engineering, Faculty of Engineering, University of Indonesia, Depok, Indonesia*
Email: [1] Muhammad.riharizky@ui.ac.id, [2] s.l.jamson@its.leeds.ac.uk, [3] leni@eng.ui.ac.id, [4] adil.afrizal31@ui.ac.id
Orchid Id: [1] 0009-0003-0403-2624, [2] 0000-0001-8166-0403, [3] 0000-0002-9975-806X, [4] 0009-0001-8064-2964
**Corresponding Author: Martha Leni Siregar*

ARTICLE INFO

Received: 30 Dec 2024

Revised: 05 Feb 2025

Accepted: 25 Feb 2025

ABSTRACT

Variable message signs (VMS) are a type of programmable electronic sign commonly positioned next to highways to provide drivers with current information. This technology can be used for effective communication between road authorities and drivers to enhance traffic management and road safety. By providing designed safety messages especially safety belts in negative and positive framing displayed on VMS, this research aims to investigate the socio-demographic factor influencing drivers to recall the message and discover the association between message framing and driver recall. To achieve this, a quantitative method was chosen, and an experiment was conducted by displaying designed messages and then addressing drivers with a questionnaire. Subsequently, the chi-square test was utilised to investigate the association among variables followed by post hoc analysis. Findings suggest that age group and driving experience influence the ability of drivers to recall the message displayed on VMS. Moreover, a message that was phrased in a negative frame was recalled significantly more frequently. The results of this research will contribute to a better understanding of how VMS can be used most effectively to improve road safety and reduce fatalities. Implementing negatively framed messaging on VMS would enhance drivers' ability to recall the presented message. Moreover, this discovery perhaps serves as a recommendation for the government to exhibit such messages to advance road safety campaigns.

Keywords: Variable message signs (VMS), message framing, recall, road safety, safety message, seat belt.

INTRODUCTION

Variable Message Signs (VMS) are electronic displays that can be programmed and are typically positioned adjacent to highways to provide drivers with up-to-date information [1]. These signs convey various information, encompassing traffic conditions, road closures, weather alerts, and safety messages. A pertinent example of employing VMS is to enhance knowledge of road safety campaigns, including seat belt usage, abstaining from alcohol consumption while driving, and maintaining mental alertness.

Seat belts are a critical safety component in vehicles, offering significant advantages. A safety belt functions by securing occupants or drivers to their seats, hence diminishing bodily forces by decelerating their motion gradually (belt elasticity). When a passenger in the front seat fastens the safety belt, the likelihood of fatal injury is diminished by 45% and the risk of moderate to critical injury is reduced by 50% during a crash [2]. Despite seat belt usage among front-seat passengers in England reaching 95.2%, the most recent traffic casualty figures for 2022 indicate that unfastened seat belts contributed to 21% of car occupant fatalities. Numerous factors contribute to people's reluctance to wear seat belts, including inconvenience and physical or emotional discomfort [3].

Due to the critical significance of seat belts in ensuring traffic safety, numerous countries have initiated seat belt usage campaigns. By using VMS, seat belt usage can be encouraged for drivers and passengers. Numerous studies claimed that the way a message is conveyed, whether highlighting the advantages of adopting the advocated behaviour or the disadvantages of avoiding from it, influences the message's efficacy and the rate of behaviour adoption [4]. Consequently, message framing must be considered when presenting messages on the VMS. The framing may consist of affirmative messages to influence drivers or adverse emotional signals to caution them.

Comprehending that message framing on Variable Message Signs is crucial for communication between road authorities and drivers. This study focuses on identifying the effectiveness of message-framing (negatively and positively framed messages) in seat belt campaigns displayed on VMS by examining the driver's recall of the messages. The research aims to investigate the influence of socio-demographic factors (gender, age group, highest level of education, employment, and driving experience) on driver recall and to identify the correlation between message framing and driver ability to remember road safety messages shown on a variable message sign (VMS).

LITERATURE REVIEW

Road safety messages are crucial for promoting improved driving behaviours and reducing the incidence of deaths and injuries caused by road accidents. To affect the behaviour of drivers and enhance road safety, these messages are disseminated via various media, including dynamic message signs, variable message signs, vehicle displays, and communication initiatives [5]. To avoid misinterpretation, road safety communications must be concise and focus on a specific safety concern. To ensure drivers can promptly comprehend the message without distraction, behavioural traffic safety (BTS) messages should be restricted to 16 words or fewer in low to moderate-workload situations and 11 words or fewer in high-workload environments [6]. Utilising comprehensible language for the target audience enhances the effectiveness of road safety messaging. Messages that elicit low-intensity negative emotions, such as melancholy, can assist drivers in identifying vulnerable road users, especially bikers. This method enhances safe driving behaviours by facilitating focus and speed management [7].

Message framing is a strategic communication technique that entails presenting information in a particular manner to influence perceptions and behaviours. It is widely utilised across various sectors, including brand marketing, healthcare, political advocacy, and environmental sustainability. The effectiveness of these communications might vary significantly according on their framing, audience characteristics, and the context in which they are delivered. In the context of road safety, message framing is essential for altering road user behaviour and advancing safety campaigns. In various communication approaches, negatively framed messages serve as a tool that highlights the detrimental consequences of specific behaviours or decisions, frequently utilising emotions such as dread, humiliation, or loss to sway the opinion of people and behaviour. A framed negative frequently employs fear dreads, which may result in psychological reactance, causing individuals to oppose the message owing to its menacing characteristics. Positive message framing is a communication strategy that prioritises the benefits or positive outcomes of a decision or action over the disadvantages of failing to make that decision or take that action. Regarding road safety, it emphasises the advantages of careful driving and may be particularly compelling in specific settings. Positively toned messaging emphasising social incentives, such as enhanced self-regard, can be particularly helpful in influencing younger drivers.

METHODOLOGY

This study investigates how drivers remember a framed message on a variable message sign (VMS). The research utilises quantitative research approaches and adheres to an experimental methodology. The experiment involves the presentation of positive and negative toned messages in distinct periods. The message was displayed on two days, with each day consisting of two sessions. In the first session, set for 10 AM to 1 PM, VMS displayed a positively framed message. In contrast, in the following session, scheduled from 2 PM to 5 PM, VMS conveyed a negatively framed message. Following the display of the message during each interval, car drivers who have passed the VMS and stopped in a designated place on an arterial road in Leeds were asked with a questionnaire with different types of messages. It will have several enquiries regarding their memory to remember the content of the message they have previously encountered.

The data collection for the study investigation took place on an arterial road in Leeds, particularly A64. Two Variable Message Signs (VMSs) are positioned on this road, one for inbound traffic towards Leeds and the other for outbound

traffic towards York. This study exclusively employs the VMS placed in the outward section. The study concentrates on car drivers travelling on the A64 road in the direction of York. A total of 91 individuals initially completed the questionnaire. Nonetheless, three participants did not complete the questionnaire in full. As a result, after filtering the data, the total number of participants is 88 individuals.

Two distinct framing methods were employed to categorise the message's content. The communication emphasised road safety which is the saefty belt initiative. The initial text was framed positively, utilising light blue and green hues. The other message was designed in negatively toned, presented in red and yellow colour. The messages presented on the VMS are illustrated in Fig. 1.

Furthermore, the method used to discover socio-demographic factors is the chi-square test which is also used to discover the association between driver recall and message framing.

Figure 1. Displayed messages

RESULT

Upon data collection, the gathered information is examined according to the characteristics of the respondents, followed by the chi-square results regarding the influence of socio-demographics as well as the impact of message framing towards recall as the followinsg description.

(a) Respondents Data

The total number of participants is 88 respondents. Table 1 indicates that approximately 88 individuals participated in the study, with females constituting a significantly greater proportion (58%) than males (42%), totalling 51 and 37, respectively. The age distribution reveals that the highest percentage (31.8%) is within the 27-36 age bracket, succeeded by those > 46 years (30.7%), while the 17-26 age group represents the smallest share (14.8%), demonstrating a very uniform distribution across the age groups. The current age distribution is rather uniform. The majority of participants possess a college or university degree (59.1%), while a smaller proportion have engaged in secondary or higher education (15.9%). The percentage of respondents possessing a post-graduate degree is 8% whereas those who have finished primary and secondary education levels account for 4.5% and 12.5% of the respondents, respectively. The job status indicates that a substantial majority, 70.5%, are employed, whilst over fifteen percent are entrepreneurs, and the rest are pensionary (13.6%). Not a single one of the participants presented themselves as students. Concerning driving experience, participants exhibit considerable variability, with 45.5% possessing less than ten years of driving experience, while 23.9% are in the age group of 11 to 20 years and the same is true for those over 30 years. Approximately 6.8% of them possess 21 to 30 years of driving experience. It indicates that the sample consists of a varied array of individuals regarding age, educational attainment, and driving experience.

Table 1. Respondent data

Gender	Freq.	%
Male	37	42
Female	51	58
Other	0	0
Age Group	Freq.	%
17 – 26	13	14.8
27 – 36	28	31.8

37 – 46	20	22.7
>46	27	30.7
Education	Freq.	%
Primary school	4	4.5
Secondary school	11	12.5
Higher or secondary or further education	14	15.9
College or university	52	59.1
Post-graduate degree	7	8
Prefer not to say	0	0
Employment	Freq.	%
Employed	62	70.5
Self-employed	14	15.9
Student	0	0
Retired	12	13.6
Other	0	0
Driving Experience	Freq.	%
≤10 years	40	45.5
11 – 20 years	21	23.9
21 – 30 years	6	6.8
>30 years	21	23.9

(b) Factors Influencing Driver Recall of Message

A statistical test: chi-square is employed to discover the demographic parameters influencing drivers' message recall. This study assessed five independent variables—gender, age group, education, employment, and driving experience—relative to recall as the dependent variable. The null hypothesis (H0) is that there is a correlation between gender and the driver's memory recall. Meanwhile, the alternative hypothesis (H1) is that there is no correlation between gender and the driver's recall. The following Table 2 shows the significant results of the chi-square test among five demographic factors followed by each description of those factors.

Table 2. Chi-square test of demographic factors and recall

	Asymptotic Significance (2-sided)				
	Gender	Age Group	Education (modified)	Employment	Driving Experience (modified)
Pearson Chi-Square	.883	**<.001**	.599	**.364**	.005
Continuity Correction[b]	**1.000**		**.765**		**.009**
Likelihood Ratio	.883	<.001	.599	.360	.004
Fisher's Exact Test					
Linear-by-Linear Association	.883	<.001	.601	.207	.005
N of Valid Cases					

1) Gender

As the result of gender identification in Table 1, there are only 2 types of gender (male and female) that are used in the chi-square test toward recall test. Therefore, considering the research includes a 2x2 contingency table, the Continuity Correction is applied as a reference. Based on Table 2, the result of the chi-square test is 1.000. This demonstrates that the alternative hypothesis (H1) fails to be rejected, whereas the null hypothesis (H0) has been confirmed to be incorrect. Since this is the case, it is possible to conclude that there is no significant association between gender and recollection.

In addition, the crosstabulation that is presented in Table 3 illustrates that there are no expected counts that are lower than 5, which indicates that the Chi-square test satisfies the necessary conditions.

Table 3. Crosstabulation gender and recall

		Recall Test	
		Not Recall	Recall
Male	Count	18	19
	Expected Count	**17.7**	**19.3**
	% within Gender	48.6%	51.4%
Female	Count	24	27
	Expected Count	**24.3**	**26.7**
	% within Gender	47.1%	52.9%

2) Age Group

The age group consists of four categories that are shown in Table 1. Therefore, the study uses a 4x2 contingency table, which means that the Pearson Chi-square formula is considered to identify the significant level. Based on Table 2, the Chi-square test reveals a value of less than 0.001. An indication that the H1 has been rejected, whereas the H0 fails to be rejected is provided by this. Consequently, a substantial correlation between age group and recall can be established. Furthermore, the results of crosstabulation show that the expected values of each category are more than 5, indicating that the Chi-square test satisfies the requisite conditions.

In addition, post hoc analysis is utilised to determine which classifications are the most significant regarding the age group variable, particularly for a contingency table with three or more groups. For this investigation, one of the choices that is made is to make use of either adjusted residuals or standardised residuals [8]. Following the null hypothesis of independence, residuals are the differences that exist between the observed and expected frequencies. This suggests that the category contributes to the overall significant chi-square test, as the large residuals indicate a bigger deviation from independence. In addition, to carry out the most accurate evaluation of the data, it is necessary to validate it by contrasting the p-value of each cell with the alpha level. Nevertheless, following multiple comparisons, there exists a risk of committing a type I error. Consequently, it is of the utmost importance to eliminate each potential paired comparison after doing a chi-square test that incorporates an explanatory variable that contains three or more groups. In the analysis of these paired comparisons, the alpha level of 0.05 is allocated throughout the total number of paired comparisons (cells), rather than maintaining the α-level (p-value) at 0.05. The revised α-level (p-value) constitutes the outcome. Given that the supplied table for the age group is a 4x2 contingency table, it has 8 cells; hence, the corrected alpha is calculated as 0.05/8=0.00625.

Based on Table 4, the 17-26 age group demonstrates greater propensity for knowledge recall than expected, as seen by a significant adjusted residual value of 2.529, indicating a lower tendency for non-recall. Nonetheless, although the p-value (0.011) is below 0.05, it exceeds 0.00625 (adjusted alpha), signifying that it remains statistically insignificant post-adjustment. The 27-36 age demographic demonstrated an unexpectedly elevated capacity for recall. However, similar to the previous age group, the p-value for this cohort (0.046) exceeds 0.00625, signifying a lack of statistical significance despite adjustment. Meanwhile, no significant differences are seen in memory or non-recall among the 37-46 age groups. The minimal residual values indicate that the observed outcomes align with the

expected value. The outcomes for the cohort over 46 demonstrate substantial statistical significance, with a p-value significantly less than 0.00625. The demographic above 46 years exhibited a significantly elevated probability of not recalling compared to expectations, including a diminished capacity for recall.

Table 4. Crosstabulation age group and recall with adjusted residual

		Recall Test	
		Not Recall	Recall
17-26 years old	Count	2	11
	Expected Count	**6.205**	**6.795**
	% within Age group	15.4%	84.6%
	Adjusted Residual	-2.529	2.529
	p_value	0.011	0.011
27-36 years old	Count	9	19
	Expected Count	**13.364**	**14.636**
	% within Age group	32.1%	67.9%
	Adjusted Residual	-1.999	1.999
	p_value	0.046	0.046
37-46 years old	Count	10.000	10.000
	Expected Count	**9.545**	**10.455**
	% within Age group	50%	50%
	Adjusted Residual	0.231	-0.231
	p_value	0.817	0.817
>46 years old	Count	21.000	6.000
	Expected Count	**12.886**	**14.114**
	% within Age group	77.8%	22.2%
	Adjusted Residual	3.755	-3.755
	p_value	0.0001735	0.0001735

3) Education

The education variable initially encompasses five categories: primary school, Secondary school, higher or Secondary or further education, College or university, and post-graduate degree. However, the results of crosstabulation reveal that four cells exhibit an expected value below 5, which means the Chi-square test fails to satisfy the conditions. Therefore, the researcher opted to alter the 6x2 contingency table to a 2x2 design. The subsequent Table 5 presents the results of the modified crosstabulation.

Table 5. Crosstabulation education and recall (modified)

		Recall Test	
		Not Recall	Recall
Primary school, Secondary school, Higher or secondary or further education	Count	15	14
	Expected Count	**13.8**	**15.2**
	% within Education	51.7%	48.3%

		Recall Test	
		Not Recall	Recall
College or university, post-graduate degree, Prefer not to say	Count	27	32
	Expected Count	**28.2**	**30.8**
	% within Education	45.8%	54.2%

Table 5 shows that all cell expected counts are above 5., indicating compliance with the Chi-square test requirements. Because of using a 2x2 contingency table, the continuity correction formula is considered. Table 2 shows that the Chi-square test produces a score of 0.765, exceeding the significance threshold of 0.05. This signifies the dismissal of the H0 and the endorsement of the H1. Consequently, it can be inferred that there is no significant correlation between educational categories and recollection.

4) Employment

As the result of employment factor identification in Table 1, only 3 kinds of employment are based on respondent characteristics. Due to the 3x2 table contingency, the significance level that is considered uses the Pearson Chi-Square formula. According to the result, Table 2 reveals that the chi-square test produces a score of 0.364. It means that the alternative hypothesis is supported, and the null hypothesis is not substantiated. This indicates that there is no substantial correlation between employment status and the ability to recall information. Furthermore, based on the crosstabulation of employment and recall that is shown in Table 6, the resulnnts of the expected count are more than 5, indicating compliance with the Chi-square test requirements.

Table 6. Crosstabulation employment and recall

		Recall Test	
		Not Recall	Recall
Employed	Count	28	34
	Expected Count	**29.6**	**32.4**
	% within Employment	45.2%	54.8%
Self-employed	Count	6	8
	Expected Count	**6.7**	**7.3**
	% within Employment	42.9%	57.1%
Retired	Count	8	4
	Expected Count	**5.7**	**6.3**
	% within Employment	66.7%	33.3%

5) Driving Experience

The driving experience variable initially consists of five categories: ≤10 years, 11 – 20 years, 21 – 30 years, and >30 years. However, the results of crosstabulation reveal that two cells (25%) are exhibiting an expected value below 5 which means the Chi-square test fails to satisfy the conditions. Thus, the researcher opted to alter the 4x2 contingency table to a 2x2 design. The subsequent Table 7 presents the results of the modified crosstabulation.

Table 7. Crosstabulation driving experience and recall (modified)

		Recall Test	
		Not Recall	Recall
≤10 and 11–20 years	Count	23	38
	Expected Count	29.1	31.9
	% within Driving Experience	37.7%	62.3%

		Recall Test	
		Not Recall	Recall
21–30 and >30 years	Count	19	8
	Expected Count	12.9	14.1
	% within Driving Experience	70.4%	29.6%

Table 7 indicates that there are no expected counts in cells below 5, representing compliance with the Chi-square test requirements. Then, because of using a 2x2 contingency table, the continuity correction formula is considered. Table 2 shows that the Chi-square test produces a score of 0.765, exceeding the significance threshold of 0.05. This indicates the alternative hypothesis (H1) fails to be rejected and the null hypothesis (H0) is not supported. Consequently, it can be inferred that there is no substantial correlation between educational groups and recall

(c) Correlation between message framing and driver retention of the message

This study categorises message framing into two separate types: positive framed messages and negative ones, both regarded as independent variables. Simultaneously, the dependent variable is the ability to recall. The subsequent stage involves analysing the two messages to ascertain any association between the framing of the messages and the recall test by the drivers. Subsequently, employing 2x2 contingency tables with a chi-square test facilitates the examination of the relationship between recall and message framing. Consistent with the prior methodology, the analytical results for the next research question are drawn in the subsequent tables.

Table 8. Crosstabulation message framing and recall

		Recall	
		No Recall	Recall
Positively framed message	Count	30	17
	Expected Count	22.4	24.6
	% within Message Framing	63.8%	36.2%
Negatively framed message	Count	12	29
	Expected Count	19.6	21.4
	% within Message Framing	29.3%	70.7%

Table 8 demonstrates that no expected values are present in cells with a count less than 5, indicating that the requisite conditions of the Chi-square test are satisfied. The study used a 2x2 contingency table, utilising the continuity correction formula

Table 9. Chi-square tests of message framing and recall

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.484[a]	1	.001
Continuity Correction[b]	9.145	1	.002
Likelihood Ratio	10.727	1	.001
Fisher's Exact Test			
Linear-by-Linear Association	10.365	1	.001
N of Valid Cases	88		

The Chi-square test which is shown in Table 9 produced a score of 0.002, which is beneath the significance threshold of 0.05. This indicates that the alternative hypothesis (H1) is not supported, whereas the null hypothesis (H0) is retained. Consequently, a substantial correlation between the framing of the message and recall can be established.

DISCUSSION

Three of the five independent variables' characteristics lack an association with recall ability. The three criteria include participants' gender, educational background, and employment. Conversely, a correlation exists between recollection and either age group or driving experience. Research indicates that drivers' cognitive abilities decline with age, significantly affecting their ability to remember information presented on traffic signs. The age variable correlates with a deterioration in cognitive capacities, such as attention, executive functions, and visuospatial skills, all of which are crucial for driving. The deterioration of cognitive ability may lead to diminished performance of drivers [9]. In addition, older drivers have a diminished velocity of traffic sign comprehension (TSC) and a less accurate judgement of contemporary traffic signs in comparison to younger people. In contrast, enhanced cognitive capacity is frequently associated with improved TSC performance [10]. The findings from these studies highlight the significant impact of cognitive related to age deterioration on drivers' ability to remember and respond to signs on road. This underscores the necessity for targeted measures and updated the designs of the traffic signs to accommodate the cognitive limitations of the elderly.

The capacity of people, particularly people who drive, to remember information displayed on the signs is affected by the length and frequency of their experience of driving, as well as the driver's familiarity with the surroundings. Research indicates that drivers with greater driving involvement have superior visual seek tactics and cognitive functioning capabilities compared to their less experienced counterparts. This can assist experienced drivers in recalling the information shown on traffic signs. For instance, seasoned drivers exhibit a greater frequency of saccadic activity during certain intervals, signifying more effective visual search strategies essential for the efficient processing of traffic sign information [11]. Meanwhile, the frequency of driving correlates with the concept of driving experience. Moreover, a direct association exists between the duration of experience of driving and the driver's age, indicating that an increase in driving experience corresponds with an increase in the driver's age. As a result, the memory capacity will also decline.

Regarding the association of message framing and recall, among 88 respondents, the framing of message distribution is varied, despite only 44 people, or half of the total, successfully recalling the message upon its presentation. Seventeen respondents, or 36.17% of the total 49 participants, retained the content of a positively framed message presented via VMS. Conversely, 27 of the 41 responders, representing 65.85% of those who received a negatively framed message, were able to recall the information. In comparison to the cohort that received affirmative signals, this percentage is nearly double.

The findings are supported by other studies indicating that messages in negatively toned are more effective to remember than if framed positively. The heightened retention of negatively framed messages can be ascribed to cognitive and emotional factors. Individuals with major depressive disorder (MDD) frequently demonstrate increased cognitive processing after encountering negative emotional cues. This consequently enhances the retention of the following information, irrespective of the emotions linked to it [12]. This behaviour is not limited to clinical groups; even healthy individuals exhibit a tendency to analyse negative messages more thoroughly. This phenomenon was noted in trials where negative health messages prompted more extended and defensive processing than positive ones [13]. This comprehensive processing is associated with the concept of negativity bias, wherein individuals typically exhibit a heightened response to negative information, which is more prone to affect their attitudes and behaviours [14]. These studies collectively demonstrate that the enhanced recall of negatively framed messages is a pervasive phenomenon shaped by profound cognitive processing, intensified emotional reactions, and the inherent negativity bias in human thought.

Furthermore, research indicates that advertisements featuring a negative frame tend to garner more awareness than those with a positive frame. A study on anti-consumption commercials revealed that negatively framed statements attracted far more attention, especially regarding the headline, than positive messages [15]. In addition, delivering a negatively framed message evokes fear, which effectively enhances attitudes, intentions, and behaviours, as corroborated by a meta-analysis [16]. This evidence can be utilised in road safety initiatives to urge drivers and passengers to adhere to regulations and guidance. The use of variable message signs (VMS) is anticipated to facilitate the recall and appropriate implementation of negatively framed messages. Moreover, it not only diminishes the incidence of traffic offences but also decreases fatalities on the roads and enhances overall road safety.

CONCLUSION

This study discovers the impact of socio-demographic elements on driver recollection and the correlation between the framing of the message and the driver's ability to recall seat belt usage messages on a VMS. It reveals that only the age and driving experience factors demonstrate significant correlations with driver recall. Furthermore, the analysis of post hoc reveals that participants over 46 years exhibit the most pronounced and statistically significant discrepancies between those who recall and those who do not. Meanwhile, the next research question reveals that the framing of the message is significantly correlated with drivers' memory. In addition, a message in a negatively framed enhances memory retention more than a positively framed one. The application of these research findings can be executed by the relevant authorities or local government. Through the use of framing messages negatively effectively utilise an alternate communication approach, particularly for disseminating road safety initiatives through diverse message indicators regarding recall. Consequently, enhancing road safety may result in a reduction in the incidence of fatalities from traffic accidents attributable to seat belt violations.

Acknowledgement:

We Muhammad Riharizky Ananda, Samantha L. Jamson, Martha Leni Siregar, and Adil Afrizal for their contributions to this work. Special thanks to Universitas Indonesia and the University of Leeds for their assistance and Ministry of Transportation Republic of Indonesia for financial support.

Funding Statement:

This research was funded by a collaboration program between the Universitas Indonesia and the Ministry of Transportation's Human Resources in implementing the double degree program. In this collaboration, Universitas Indonesia through the Department of Civil and Environmental Engineering, Faculty of Engineering, provides a post-graduate program in Civil Engineering for specialization in transportation. As for the foreign universities that will be addressed, the University of Leeds through the Institute for Transport Studies (ITS) provides master's programs in various fields of transportation expertise.

Conflict of Interest:

The authors declare that there is no conflict of interest

REFERENCES

[1] E. Kassens-Noor, P. T. Savolainen, T. J. Gates, M. Cai, and T. Deaminada, "Communicating safety with drivers via dynamic message signs," *Transportation Research Part F: Traffic Psychology and Behaviour,* vol. 81, pp. 417-430, 2021/08/01/ 2021, doi: https://doi.org/10.1016/j.trf.2021.06.010.

[2] N. H. T. S. A. NHTSA. "Seat Belts." National Highway Traffic Safety Administration https://www.nhtsa.gov/vehicle-safety/seat-belts (accessed 28 April, 2024).

[3] D. f. T. DfT, "Strapping Yarns: Why People Do and Do Not Wear Seat Belts," Department for Transport, London, November 2008 2008, vol. 98.

[4] N. Chaurand, F. Bossart, and P. Delhomme, "A naturalistic study of the impact of message framing on highway speeding," *Transportation Research Part F: Traffic Psychology and Behaviour,* vol. 35, pp. 37-44, 2015/11/01/ 2015, doi: https://doi.org/10.1016/j.trf.2015.09.001.

[5] S. I. A. Shah and M. Shahzad, "Perception of Vehicle Drivers about the "Road Safety on Wheels" Awareness Campaign in Punjab Province, Pakistan," *Journal of Education and Social Studies,* vol. 4, no. 3, pp. 525-533, 10/17 2023, doi: 10.52223/jess.2023.4312.

[6] G. L. Ullman *et al.*, "Driver Understanding and Secondary Task Performance While Viewing Traffic Safety Messages on Dynamic Message Signs," *Transportation Research Record,* vol. 2677, no. 9, pp. 164-174, 2023, doi: 10.1177/03611981231158626.

[7] A. Lafont, J. Rogé, D. Ndiaye, and J.-M. Boucheix, "Road safety communication effectiveness: the roles of emotion and information in motorists' ability to detect vulnerable road users," *Cognition, Technology & Work,* vol. 24, no. 2, pp. 333-349, 2022/05/01 2022, doi: 10.1007/s10111-021-00692-x.

[8] T. M. Beasley and R. E. Schumacker, "Multiple Regression Approach to Analyzing Contingency Tables: Post Hoc and Planned Comparison Procedures," *The Journal of Experimental Education,* vol. 64, no. 1, pp. 79-93, 1995. [Online]. Available: http://www.jstor.org/stable/20152474.

[9] L. Eudave and M. Pastor, "Cognition and driving in older adults: a complex relationship," *Aging,* vol. undefined, 02/21 2023, doi: 10.18632/aging.204551.
[10] P. Schulz *et al.*, "Age effects on traffic sign comprehension," *IATSS Research,* vol. 44, 10/01 2019, doi: 10.1016/j.iatssr.2019.10.001.
[11] L. Han, Z. Du, and S. He, "The effects of the traffic signs information volume on the visual characteristics and workload of novice and experienced drivers," (in eng), *Work,* Apr 2 2024, doi: 10.3233/wor-230349.
[12] S. Miron and E. Kalanthroff, "Negative emotional cues improve free recall of positive and neutral words in unmedicated patients with major depressive disorder," (in eng), *Cogn Behav Ther,* vol. 53, no. 4, pp. 409-422, Jul 2024, doi: 10.1080/16506073.2024.2328288.
[13] M. Brown and R. Gold, "Cognitive responses to positively and negatively framed health messages: A thought-listing study," *Psychology, health & medicine,* vol. 19, 12/17 2013, doi: 10.1080/13548506.2013.871305.
[14] A. I. Itani *et al.*, "Are negative frames equally sticky across cultural contexts? Exploring sequential framing effects with Arab participants in the UAE," *Current Research in Ecological and Social Psychology,* vol. 5, p. 100129, 2023/01/01/ 2023, doi: https://doi.org/10.1016/j.cresp.2023.100129.
[15] C. Zunckel, P. Pillay, M. H. Drummond, and D. Rosenstein, "Advertising to reduce meat consumption: positive framing versus negative framing effects on attention," *Journal of Social Marketing,* vol. 13, no. 4, pp. 609-630, 2023, doi: 10.1108/JSOCM-03-2023-0062.
[16] M. B. Tannenbaum *et al.*, "Appealing to fear: A meta-analysis of fear appeal effectiveness and theories," (in eng), *Psychol Bull,* vol. 141, no. 6, pp. 1178-204, Nov 2015, doi: 10.1037/a0039729.