ANALYSIS OF THE EFFECT OF WEATHER CONDITIONS AND CONVERSATIONS ON DRIVER SITUATION AWARENESS USING THE SITUATION AWARENESS RATING TECHNIQUE (SART) METHOD

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Abstract

Driving is an activity of controlling vehicles on the road, either using motorcycles or cars that can pose a risk of accidents, the factors that cause accidents include human factors, vehicle factors, and environmental factors. The purpose of this study was to determine the effect of weather conditions and conversation on the situation awareness of car drivers (driving simulator) using the Situation Awareness Rating Technique (SART) method. The research subjects are Industrial Engineering students of UPN "Veteran" East Java, while the research object is situation awareness during sunny and rainy weather conditions, with and without being invited to a conversation. The statistical test used is the paired sample t-test. there is no difference in the average SA value or no significant effect on sunny weather conditions without being invited to a conversation and with being invited to a conversation which shows a sig. (2-tailed) of $0.578 > 0.05$. Whereas in rainy weather conditions without being invited to have a conversation and with being invited to have a conversation there is a difference in the average SA value or there is a significant effect on the driver where the sig value. (2-tailed) of $0.024 < 0.05$.

Keywords: Conversations, Driving Simulator, Situation Awareness, Situation Awareness Rating Technique, rainy weather, sunny weather

INTRODUCTION

Driving is an activity of controlling or controlling a vehicle, either using a motorcycle or car, which can pose a high risk such as loss, damage, loss, and death due to accident. Other activities carried out while driving can interfere with and distract from driving activities which are the main cause of accidents. According to BPBD Surabaya data, the number of traffic accidents that occurred in the city of Surabaya, namely in 2020 amounted to 1741, in 2021 amounted to 1262, and in 2022 amounted to 2132 events. Based on this data, it is known that the number of accidents increases every year, while

the factors that cause accidents include human factors, vehicle factors, and environmental factors (road conditions and nature).[1] In addition, Jasa Raharja also states that those who are often involved in accidents are in the student age group aged 16-25 years as many as 515 people, followed by the productive age group 26-55 years as many as 504 people, and the elderly age group> 56 years as many as 218 people.

While driving, drivers certainly need Situation awareness (SA) to identify information relevant to dynamic traffic conditions.[2] This ability is related to the driver's mental state which is greatly influenced by factors outside of driving techniques.[3] There are several things that can cause a person to be unable to concentrate and reduce the level of alertness while driving, namely due to various distractions while driving.[4] According to the NSC (National Safety Council) distraction causes around 1.6 million accidents every year.[5] Distraction can come from physical distraction, visual distraction, cognitive distraction, and auditory distraction. Auditory or sound distractions can cause decreased concentration and decreased cognitive performance, depending on the type and intensity of the sound heard while working.[6] In another study, it showed that as many as 27.3% of drivers who received sound disturbances had accidents.[7] Activity that drivers often do while driving is chatting with traveling companions with a percentage of 48.5% frequency. This can increase the risk of accidents, because the conversations carried out can distract the driver's attention and will have an impact on reducing the level of situational awareness or alertness while driving.[8]

In addition to distractions, there are also environmental factors such as bad weather. Bad weather, such as rain, can disrupt traffic and cause accidents. In addition to causing

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[1] Maulana, A., Muna, K. U., & Asjtanto, H. (2023). Mapping and Trend Analysis of Accident Rates in Surabaya City. SEHATRAKYAT (*Journal of Public Health*), 2(2), 250-257. doi:DOI: 10.54259/sehatrakyat.v2i2.1663

[2] Wijayanto, T., Marcillia, S.R., Lufityanto, G., Wisnugraha, B.B., Alma, T.G. and Abdianto, R.U., (2020). The effect of situation awareness on driving performance in young sleep-deprived drivers. *IATSS Research*.

[3] Van Dam, J., Kass, S.J. and VanWormer, L., (2020). The effects of passive mobile phone interactionon situation awareness and driving performance. *Journal of Transportation Safety & Security*, Vol. 12, No. 8, pp.1007-1024

[4] WHO (2020). *Road Traffic Injuries*. Accessed on February 20, 2024 from: https://www.who.int/news-room/fact-sheets/detail/road-traffic-injurie

[5] Doshi, K., & Yilmaz, Y. (2022). Federated learning-based driver activity recognition for edge devices. *In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 3338-3346)

[6] Liu, H., He, H., & Qin, J. (2021). Does Background Sounds Distort Concentration And Verbal Reasoning Performance In Open-Plan Office. *Applied Acoustics*, 172, 107577.

[7] Wundersitz, L. (2019). Driver Distraction and Inattention In Fatal And Injury Crashes: Findings From In-Depth Road Crash Data. *Traffic injury prevention*, 20(7), 696-701.

[8] Halim, W., Sarvia, E., Heryanto, R. M., Caroline, C., & Dacosta, G. B. (2021). Effect of Musical Accompaniment and Live Conversation on Driving Characteristics Using a Driving Simulator. *Scientific Journal of Industrial Engineering*, 9(3), 223-232.

accidents, bad weather can also trigger congestion. However, in this case the congestion that occurs does not affect the weather conditions that occur.[9] When it rains it causes a significant increase in the likelihood of road accidents.[10] Weather conditions have a significant influence on car following behavior. The driver's perceived risk tends to increase as weather conditions worsen. In very poor visibility conditions, the driver's perceived risk is low due to difficulties in vehicle operation and limited visibility.[11] This shows that bad weather has a great impact on driver behavior, which puts vehicles and drivers in dangerous situations that can easily lead to traffic accidents.

From the above problems, it is necessary to research the effect of weather conditions and conversations on the driver's situation awareness, where weather conditions are indirect disturbances and conversations are direct disturbances given to the driver. This driver's SA can be measured using the SART (Situation Awareness Rating Technique) method, Therefore, this study aims to investigate the influence of weather conditions and conversation on driver situation awareness based on the SART method. This research is also expected to provide recommendations that can improve driver situation awareness which can reduce the risk of accidents.

RESEARCH METHODS

Subject and Object of Research

The research subjects are Industrial Engineering students of UPN "Veteran" East Java, while the research object is situation awareness during sunny and rainy weather conditions, with and without being invited to a conversation.

Sample and Population

This research was conducted using experiments, for experimental research with a complete randomized design, randomized group or factorial, it can simply use the Federer formula, as follows:

$$(n-1)(t-1) > 15^{12}$$

Based on the above formula with 4 treatments, the number of samples required is more than or equal to 6 and in this study the number of samples taken was 8 respondents with a total of 32 replications, so that it has met the minimum number of samples and replications.

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[9] Liana, Azalia Sirsa and Drs. Umrotun, M.Si. (2019) *The Relationship between Traffic Congestion and Air Temperature in Pandanaran Road Section, South Semarang District, Semarang City.* Thesis, University of Muhammadiyah Surakarta.

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[12] Sabban, I. F., Wahyuni, I. N., Erawati, E., Hermawan, R. A., Nela, F. V., Kurniawan, A. E., & Anggraini, E. R. (2021). Effect of Centrifugation Speed and Time on Sedimentation in Making Preparations for Microscopic Examination of Urine. *In Proceedings of the 2020 Research Results Seminar.*

Research Instruments

The following are the instruments contained in this research:

1. Driving simulator, as a driving simulation tool that respondents will use during the experiment.
2. Software city car driving, simulation game that respondents used to drive using a driving simulator, by setting the traffic density at 50% and pedestrians at 40%, so that respondents can feel the driving conditions close to the original conditions.[13]
3. SART questionnaire form, contains statements to measure the driver's situation awareness level.

Operational Definition Of Variables

Referring to the research problem, the following research variables can be identified:

1. Weather Conditions

Weather is the state of the air at a certain time and in a certain area that is relatively narrow and for a short period of time. Weather is formed from a combination of weather elements and the weather period can only be a few hours.[14] in this study only uses two weather conditions, namely sunny and rainy weather.

2. Conversation

Conversation is one of the communication activities that involve participants or other people, in short, interactive communication between two or more people.[15] In this study, conversations were conducted to provide distractions to take the driver's attention away from the driving task.

3. Situation Awareness

According to Stanton, Situational awareness is a person's ability to understand and interpret the surrounding environment, by paying attention to relevant information and processing it to make the right decisions. SA is measured by the SART questionnaire using an ordinal measurement scale with a unit score of 1 to 7. SA variables in SART are demand, supply, and understanding. Demand is the demand for attention resources, supply is the supply of attention resources, and understanding

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[13] Hadyanawati, A. A., Pratama, T., & Widyasari, C. F., (2019). Analysis of the Effect of Traffic Density Level and Gender on Situational Awareness. *IDEC National Seminar and Conference*, E18.1-E18.6.

[14] Susilo, B., (2021). *Understanding Climate and Weather in Indonesia*. Yogyakarta: DIVA Press

[15] Barus, R.P. Barus, R. (2019). Intercultural Communication in the Aron Community in Berastagi. *Journal of Symbolics: Research and Learning in Communication Study*, 5 (2): 118-131

is the understanding of the situation.[16] The SA variables in SART are demand, supply, and understanding as follows:

A. Demand, is the demand for attention resources. The demand parameter is, situation instability, situation complexity, and situation variability
B. Supply, is the supply of the source of attention. The supply parameter is, arousal or readiness, concentration of attention, division of attention, and mental capacity
C. Understanding, is the understanding of the situation. The parameter of understanding is, quantity of information received and familiarity with the situation[17]

Research Procedures

The experimental procedure in this study consists of several stages that need to be done, namely:

1. Provide information to respondents in the form of the purpose and mechanism of the experiment. The instrument used for the experiment is the situation awareness rating technique (SART) questionnaire, which is useful for measuring the respondent's situation awareness condition while driving, by providing an assessment using an ordinal measurement scale with a unit score of 1 to 7. Respondents are required to drive as usual, including obeying the traffic rules contained in the software. At this stage, it will also be informed that the treatment will be given in the form of intervention using distraction, namely driving without being invited to have a conversation and with being invited to have a conversation.
2. The respondents were given an explanation when using the city car driving software and console driving simulator. Next, the respondents were invited to do driving training, so that they could experience all the same conditions as the experimental scenario. The free-driving training phase was conducted for 3-5 minutes.
3. The respondent will be given a start signal to the respondent which indicates the start of the driving simulation with the vehicle already on, handbrake off, and has used a seat belt. Respondents will drive in accordance with traffic regulations and respondents are required to follow the appropriate road directions listed in the city car driving software. Respondents conducted 4 driving scenarios with the same length of time, namely each scenario was run for 10 minutes and carried out sequentially. When changing scenarios, respondents are given a 3-5 minute break and given a SART questionnaire form to fill in the level of SA felt in each scenario or treatment that has been given.

Data Processing and Analysis

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[16] Aminuddin AP, R. A. (2023). Analysis of the Application of Cognitive Ergonomics with the Situational Awareness Rating Technique Method for BRT Drivers Based on Work Shift. *Journal Industrial Engineering and Management (JUST-ME)*, 4(1), 27-35. doi:https://doi.org/10.47398/justme.v4i01.38

[17] Mazur, L.M., Adams, R., Mosaly, P.R., Stiegler, M.P., Nuamah, J., Adapa, K., Chera, B. and Marks, L.B., (2020). Impact of Simulation-Based Training on Radiation Therapists' Workload, Situation awareness, and Performance. *Advances in Radiation Oncology*, Vol. 5, No. 6, pp.1106-1114.

Data processing and analysis in this study using Microsoft Excel and SPSS software. Data analysis itself is useful for interpreting and drawing conclusions from a number of data collected. The following is the method used for data processing and analysis.

1. Calculating The SA Value

Calculate the situation awareness value generated from the SART questionnaire score of each driver with the following formula:

$$SA = Understanding - (Demand - Supply)[18]$$

2. Test Of Normality

The data normality test is a test used to see whether numerical data is normally distributed or not. The data normality test can be used using the Shapiro Wilk test because the amount of data is small.[19]

3. Paired Sample T-test

Paired sample t-test is used to test whether there are differences in the means of two paired groups, namely the same group of subjects with two different treatments or measurements.[20]

RESULT AND DISCUSSION

Characteristics Of Respondents

The following are the characteristics of each respondent in this research.

Table 1. Characteristics Of Respondents

Respondents	Age	Driver's License (SIM A)	Physically and mentally healthy
1	21	Yes	Yes
2	21	Yes	Yes
3	21	Yes	Yes
4	21	Yes	Yes
5	22	Yes	Yes
6	22	Yes	Yes
7	22	Yes	Yes
8	22	Yes	Yes

Source: Data Processing, 2024

[18] Aminuddin AP, R. A. (2023). Analysis of the Application of Cognitive Ergonomics with the Situational Awareness Rating Technique Method for BRT Drivers Based on Work Shift. Journal Industrial Engineering and Management (JUST-ME), 4(1), 27-35. doi:https://doi.org/10.47398/justme.v4i01.38

[19] Aminah, S., Radita, N., & Widodo, S. (2021). Experimentation of Online Learning with Video Conference in Informatics Engineering Study Program during Pandemic. *Teknika*, 10(1), 37-42. https://doi.org/10.34148/teknika.v10i1.323

[20] Sobarna, A., Hambali, S., Rizal, R. M., & Sevtiadzi, L. (2019). Results of Jumping Skills (Experimental Study Using Plyometric Exercises). *Journal of Sports Education*, 8(1), 53-61.

Based on the table 1 above, the respondents have met the qualifications in the terms of respondents in this study, namely, respondents are students of Industrial Engineering UPN "Veteran" East Java, have a car driving license (SIM A), and are in good physical and spiritual health.

Driver Situation Awareness

The following are the results of processing or calculating the driver's situation awareness value.

1. Situation Awareness Score of Drivers with Sunny Weather Conditions without Conversation (Treatment 1)

Table 2: SART Questionnaire Results Sunny Weather Without Conversation

R	SART Questionnaire									SA Results
	D1	D2	D3	S1	S2	S3	S4	U1	U2	
1	4	3	4	4	5	5	5	5	6	19
2	2	3	3	5	5	3	4	5	6	20
3	3	3	3	4	5	4	3	5	5	17
4	2	3	4	5	5	3	2	6	5	17
5	3	4	4	5	5	4	3	5	6	17
6	3	4	3	5	6	4	4	5	4	18
7	3	5	4	5	5	4	6	7	4	19
8	3	2	3	4	5	5	6	4	6	22
Mean	2.875	3.375	3.5	4.625	5.125	4	4.125	5.25	5.25	18.625

Source: Data Processing, 2024

Based on table 2 above, it can be seen that the first treatment with clear weather conditions without being invited to have a conversation on demand 1, namely changes in the situation, has the lowest value with an average value of 2.875, which means that the driver feels very stable and the situation tends not to change. While the highest value is found in undersantanding 1 and 2, namely the amount of information obtained by the driver and the amount of experience or recognition of the situation with a value of 5.25, which means that the driver has received and understood a lot of information and has a lot of experience relevant to the situation.

2. Situation Awareness Score of Drivers in Sunny Weather Conditions with Conversation (Treatment 2)

Table 3. Sunny Weather SART Questionnaire Results With Conversation

R	SART Questionnaire									SA Results
	D1	D2	D3	S1	S2	S3	S4	U1	U2	
1	4	4	5	5	6	6	5	5	5	19
2	6	5	6	5	5	5	6	4	4	12
3	6	6	5	5	7	5	4	4	5	13
4	7	6	5	3	7	4	4	5	4	9
5	4	5	6	7	7	7	7	5	7	25
6	3	4	6	6	7	7	6	6	6	25
7	4	4	5	5	5	5	6	5	4	17
8	3	5	4	6	5	4	6	5	5	19

Mean	4.625	4.875	5.25	5.25	6.125	5.375	5.5	4.875	5	17.375

Source: Data Processing, 2024

Based on table 3 above, it can be seen that the second treatment with sunny weather conditions by being invited to talk to demand 1, namely changes in the situation, has the lowest value with an average value of 4.625, which means that the driver feels very stable and the situation tends not to change. While the highest value is in supply 2, namely concentration on the situation with a value of 6.125, which means that the driver can devote all his thoughts.

3. Situation Awareness Score of Drivers with Rainy Weather Conditions without Conversation (Treatment 3)

Table 4. Rainy Weather SART Questionnaire Results Without Conversation

R	SART Questionnaire									SA Results
	D1	D2	D3	S1	S2	S3	S4	U1	U2	
1	4	4	5	5	4	5	6	4	5	16
2	3	2	4	5	6	4	4	5	5	20
3	4	2	3	4	5	5	5	4	5	19
4	5	4	3	4	5	5	5	4	4	15
5	5	4	4	5	6	5	6	5	5	19
6	4	4	3	5	6	6	5	4	4	19
7	5	5	5	5	4	4	5	6	4	13
8	5	4	5	5	6	3	6	6	5	17
Mean	4.375	3.625	4	4.75	5.25	4.625	5.25	4.75	4.625	17.25

Source: Data Processing, 2024

Based on table 4 above, it can be seen that the third treatment with rainy weather conditions without being invited to talk to demand 2, namely the level of complexity of the situation, has the lowest value with an average value of 3.625, which means that the driver feels the situation experienced is simple and uncomplicated. While the highest value is found in supply 2 and 4, namely concentration on the situation and mental capacity possessed in the existing situation with a value of 5.25, which means that the driver can devote all his thoughts and the driver feels sufficient or able to pay attention to the existing situation.

4. Situation Awareness Score of Drivers in Rainy Weather with Conversation (Treatment 4)

Table 5. Rainy Weather SART Questionnaire Results With Conversation

R	SART Questionnaire									SA Results
	D1	D2	D3	S1	S2	S3	S4	U1	U2	
1	5	5	6	6	5	6	6	3	4	14
2	6	6	5	6	6	5	4	4	3	11
3	5	6	5	5	6	6	4	3	4	12
4	7	7	6	5	7	6	5	4	4	11
5	7	7	6	7	7	7	7	5	5	18
6	7	6	6	6	7	7	5	3	3	12
7	6	5	7	6	7	5	7	4	4	15

8	6	6	5	6	6	5	5	5	5	15
Mean	6.125	6	5.75	5.875	6.375	5.875	5.375	3.875	4	13.5

Source: Data Processing, 2024

Based on table 5 above, it can be seen that the fourth treatment with rainy weather conditions with conversation in understanding 1, namely the amount of information obtained by the driver, has the lowest value with an average value of 3.875, which means that the driver receives and understands very little information. While the highest value is in supply 2, namely concentration on the situation with a value of 6.375, which means that the driver devotes all his thoughts to the situation at hand.

**Comparison of Situation Awareness (SA) Aspects of Drivers**

The following is a comparison of the average value of the SA aspect of the driver with the treatment that has been given.
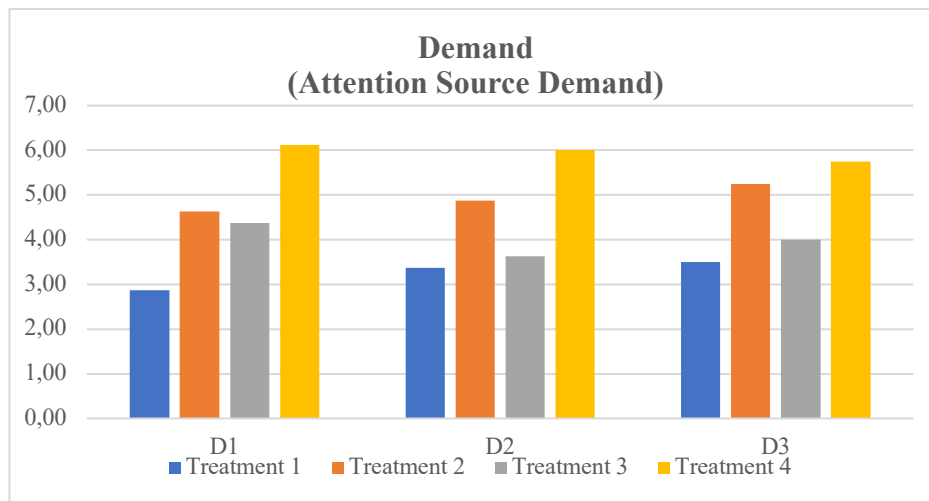
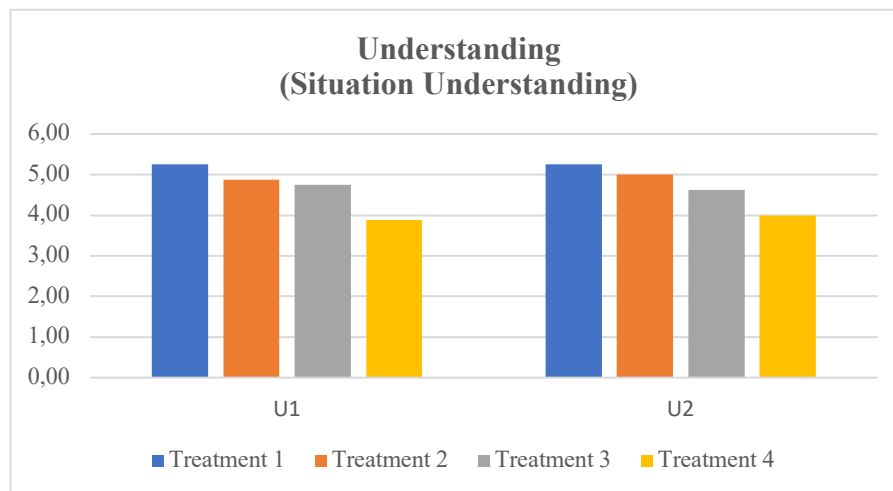**Figure 1. Driver Demand Results**

Source: Data Processing, 2024

Based on Figure 1 above, it can be seen that the demand for sources of attention in the first treatment (sunny weather without conversation) is lower than the fourth treatment (rainy weather with conversation). This means that in the first treatment the driver feels that the situation is very stable, there is no complexity or simplicity, and only a few factors change. Whereas in the fourth treatment the driver felt the situation was unstable, there was complexity, and many factors changed.
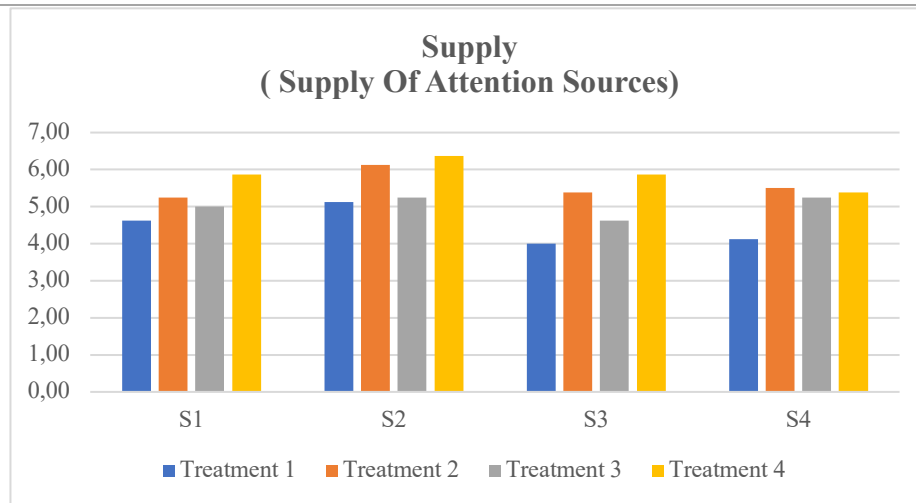
Figure 2. Driver Supply Results

Source: Data Processing, 2024

Based on Figure 2 above, it can be seen that the supply of attention sources in the first treatment (sunny weather without conversation) is lower than the fourth treatment (rainy weather with conversation). This means that in the first treatment the driver felt a lower level of alertness, attention, and concentration to the situation at hand. Whereas in the fourth treatment the driver felt the level of alertness, attention, and concentration to the situation at hand was higher.
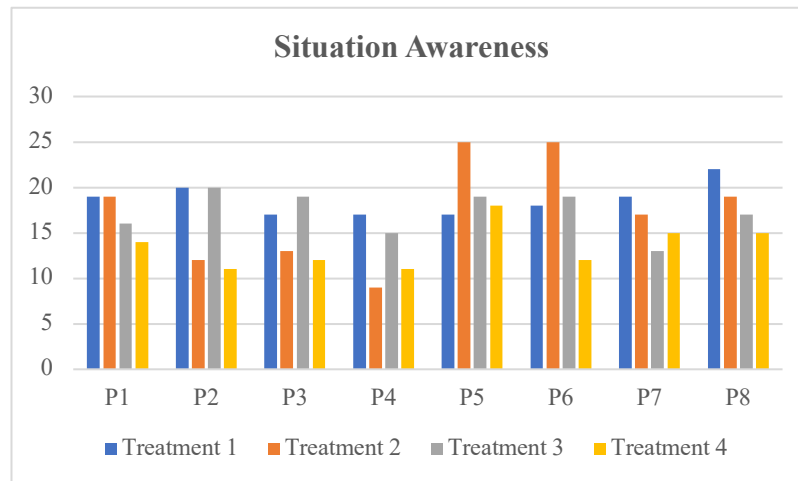

Figure 3. Driver Understanding Results

Source: Data Processing, 2024

Based on Figure 3 above, it can be seen that the understanding of the situation in the fourth treatment (rainy weather with conversation) is lower than the first treatment (sunny weather without conversation). This means that in the fourth treatment, drivers felt that they received and understood little information, and did not have much experience with the situation. Whereas in the first treatment, drivers felt they received and understood a lot of information, and had a lot of experience with the situation.

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Drivers Situation Awareness (SA) Comparison

The following is a comparison of the situation awareness value of each driver who has been given several treatments.

Figure 4. Comparison Of Driver SA Scores

Source: Data Processing, 2024

Based on Figure 4 above, it can be seen that the value of situation awareness or awareness of the situation while driving is the highest value in the first treatment, which means that in sunny weather conditions without being invited to conversation, awareness and understanding of the situation around the driver is very high. While the lowest situation awareness value is found in the fourth treatment, which means that in rainy weather conditions with conversation, awareness and understanding of the situation around the driver is very low.

Statistical Test

The following are the statistical tests carried out in this research :

1. Normality Test

Paired Samples Test

		Paired Differences							
				Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
		Mean	Std. Deviation		Lower	Upper			
Pair 1	Cerah_tanpa_percakapan - Cerah_dengan_percakapan	1.250	6.065	2.144	-3.821	6.321	.583	7	.578
Pair 2	Hujan_tanpa_percakapan - Hujan_dengan_percakapan	3.750	3.694	1.306	.662	6.838	2.872	7	.024

Figure 5. Normality Test Results

Source: Data Processing, 2024

Based on Figure 5 above, it can be seen that the results of the significance value of the normality test in this study using the Kolmogorov-Smirnov and Shapiro-Wilk tests are> 0.05, this states that the data is normally distributed.

2. Paired Sample T-test

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Cerah_tanpa_percakapan - Cerah_dengan_percakapan	1.250	6.065	2.144	-3.821	6.321	.583	7	.578
Pair 2	Hujan_tanpa_percakapan - Hujan_dengan_percakapan	3.750	3.694	1.306	.662	6.838	2.872	7	.024

Figure 6. Paired Sample T-test Results

Source: Data Processing, 2024

Based on Figure 6 above, it can be seen that the Pair 1 output obtained a sig value. (2-tailed) of 0.578 > 0.05, it can be concluded that there is no difference in the average value of situation awareness (SA) in sunny weather conditions without being invited to have a conversation with sunny weather conditions with being invited to have a conversation. While in the Pair 2 output, the sig value is obtained. (2-tailed) of 0.024 < 0.05, it can be concluded that there is a difference in the average value of situation awareness (SA) in rainy weather conditions without being invited to talk with rainy weather conditions with being invited to talk.

CONCLUSION

During sunny weather conditions without being invited to have a conversation and with being invited to have a conversation has no significant effect on the driver's situation awareness, with an average driver SA value of 18.625 and 17.375. Whereas in rainy weather conditions without being invited to have a conversation and with being invited to have a conversation has a significant effect on the driver's situation awareness, which has an average driver SA value of 17.25 and 13.5. this is in line with the results of the paired sample t-test, namely, there is no difference in the average SA value in sunny weather conditions without being invited to have a conversation and with being invited to have a conversation which shows a sig. (2-tailed) of 0.578 > 0.05. While in rainy weather conditions without being invited to talk and with being invited to talk, there is a difference in the average SA value of drivers where the sig. (2-tailed) of 0.024 < 0.05.

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