Situation Awareness Analysis on Motorcycle Riders using Quantitative Analysis of Situational Awareness

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Abstract. A Traffic accident is caused by the negligence and the low situation awareness of the motorcycle riders. Based on the Indonesian Police traffic data, until May 2018, there were 32,127 motorcycle accidents with 6,009 people died. The highest accidents happened to the riders between 15-19 years old. Thus, feasibility of the motorcycle riders becomes crucial. The purpose of this study is to determine the level of awareness of the motorcycle riders as well as to determine the minimum age level to ride motorcycle. There were 75 respondents participating in this study who were about 17 to 19 years old. The Quantitative Analysis of Situational Awareness method was used to achieve the objective. The results of this study show that 17 years old riders have better situation awareness level than 18 years old ones. Meanwhile, the best situation awareness level is at age 19. It is because of the value of calibration (12.22%) which is smaller than 17 years old (17.52%) and 18 years old riders (26.48%). Therefore, this study recommends the feasibility of motorcycle riders should be 19 years old as the minimum requirement.

Keywords: Quantitative Analysis, Situational Awareness, Calibration, Level of Awareness

1. INTRODUCTION
The number of motorcycle accidents is caused by the rider's negligence and low situation awareness. Many accidents are caused by riders' low situation awareness [2]. Based on the Indonesian Police traffic data, until May 2018, there were 32,127 motorcycle accidents with 6,009 people died, and the rest experienced minor and severe injury [3]. The accidents were dominated by riders between 15-19 years old [3]. Most of them had not had a driving license even though they were able to ride. However, the facts show that there are still many accidents happened. It indicates that the riders' level of awareness has not satisfied the requirements. Thus, the feasibility of motorcycle riders is considered crucial.

Many studies have been done related to the situation awareness like those done by [2], [4], [7-8]. Febrianti, et al. (2013) found that a driver has lack of confidence even though the skill of driving is good for the public car driver. While [2] investigated the situation awareness of young car drivers. He found that most of the young drivers have low of situation awareness. It is because they tend to feel confident but the technique of driving is still unstable. In addition, numerous causes of accidents at the pilot including the perception, understanding of the situation, and anticipation of the future event had been investigated by [8]. Fang, et al. (2018) studied the assessment of operator’s situation awareness
for the smart operation of mobile cranes. It was identified that to increase the performance, the situation awareness should be improved. High self-confidence in driving that is incomparable to the appropriate driving method will endanger the drivers themselves and those around them, which will lead to high accident rates [2] [4].

This study focuses on assessing the actual accuracy value and perceived accuracy value to identify the characteristic of situation awareness and to determine the level of awareness of the motorcycle riders. This study also develops a recommendation and requirement of the minimum age for the feasibility of riding a motorcycle.

2. RESEARCH METHOD

2.1 Survey

In this study, determination of the sample can be determined using the following formula [1]:

\[ n = \frac{N}{1 + N(e)^2} \]  

And:  
- \( n \) = number of samples  
- \( N \) = population  
- \( e \) = critical value / desired accuracy limit

The critical value of 0.2 or 20% is used. Based on the data from the population of Sleman, Yogyakarta, in 2016, the number of residents age 15-19 amount up to 90,833 people (BPS, 2017). Therefore the calculation results in 75 respondents. Participants have an ability in riding motorcycle. They are divided into three groups with 25 people for each group. Group 1 is for 17 years old riders, group 2 is for 18 years old ones, and group 3 is for 19 years old ones. Each respondent is instructed to answer a situation awareness questionnaire consisting of 28 statements. The answer has two types of scores those are the actual accuracy score and perceived accuracy score.

2.2 Apparatus

The tools used to support the research are:

1. Questionnaire for testing the situation awareness
2. IBM SPSS software version 22 that offers advanced statistical analysis.
3. Microsoft Excel to calculate the value of research results.

2.3 Situation Awareness

There are three levels of situation awareness in the Endsley model i.e. perception of elements in the environment related to the task and purpose, understanding of the importance of the elements and the formation of mental models, and the predictions of the future [4] [5].

2.4 Quantitative Analysis of Situational Awareness (QUASA)

Quantitative Analysis of Situational Awareness (QUASA) is a technique that combines both objective questions (true/false probes) and subjective self-confidence ratings for each response [6]. Calibration of Situation Awareness is conducted to assess the level of suitability between actual accuracy and perceived accuracy as a proportion of error. Calibration can be determined by giving a trust rating. Trust ratings can be binary rank, ordinal multi-category rank, or sustainable scale [5]. The result is shown in a curve which consists of Y axis for actual accuracy (%) and X axis for perceived accuracy (%) [2] [7] [6]. The criteria of the calibration curve can be classified as follow [7]:

1. Over-confident means that the riders have self-confidence in riding, but the riding skill is still unstable.
2. Under-confident means that the riders have lack of self-confidence in riding, but the riding skill is stable.

As for the steps of data analysis by using this method is as follow:

1. Calculating the total score for actual accuracy and perceived accuracy is by equation [2]:

\[ \text{Total Score} = \frac{\text{Actual Accuracy} + \text{Perceived Accuracy}}{2} \]
Total score = \text{number of questions} \times \text{number of respondents} \times 100\% \quad (2)

2. Determining the percentage for actual accuracy and perceived accuracy through equations [2]:

To determine the actual accuracy value:
\[
\text{Actual accuracy} = \frac{\text{number of respondent answers correctly}}{\text{total score}} \times 100\% \quad (3)
\]

To determine the value of perceived accuracy:
\[
\text{Perceived accuracy} = \frac{\text{total respondent's confidence score}}{\text{total confidence level score}} \times 100\% \quad (4)
\]

Where the confidence score is calculated as below [6]:
Confidence score = (k1 \times 100\%) + (k2 \times 75\%) + (k3 \times 50\%) + (k4 \times 25\%)
And: k1 = number of respondents who answered very confidently
k2 = number of respondents who answered confidently
k3 = the number of respondents who answered was pretty sure
k4 = number of respondents who answered less confidently

3. Developing a calibration curve is based on the results of step 2 (Y-axis that is actual accuracy and the X-axis is perceived accuracy).

4. Determine the level of awareness for each group of age is below [2]:
\[
\text{Level of Awareness} = \frac{\sum (\text{confidence level score} \times \text{correct answer score})}{\text{total score}} \times 100\% \quad (5)
\]

5. Analyzing the results and the recommendations.

3. RESULTS AND DISCUSSION

3.1 Result of Statistical Analysis
Determination of the validation of each item statement through validity testing using Pearson Product Moment shows that 27 statements are valid, yet 1 statement is invalid, so that the reliability test performed using Cronbach's Alpha is 27 statements with high reliability.

3.2 Result of Calibration of Situation Awareness
The result of this study can be seen in Table 3.1 and Figure 3.1, Figure 3.2, and Figure 3.3. Table 3.1 shows the value of actual accuracy, perceived accuracy, and an error value for each age. While Figure 3.1, Figure 3.2, and Figure 3.3 are the result of calibration of situation awareness calculation for 17 years old, 18 years old, and 19 years old respectively.

| Age | Actual Accuracy | Perceived Accuracy | Error Value |
|-----|-----------------|--------------------|-------------|
| 17  | 62.96\%         | 80.48\%            | 17.52\%     |
| 18  | 51.11\%         | 77.59\%            | 26.48\%     |
| 19  | 66.52\%         | 78.74\%            | 12.22\%     |

Table 3.1 Perceived Accuracy and Actual Accuracy Values
Based on Figure 3.1 and Table 3.1, the actual accuracy value is 62.96% which is lower than the perceived accuracy value of 80.48%, it means the respondent's level of self-confidence is higher than what is actually experienced, then the error value is 17.52% which means the curve does not show well calibrated. So that, the characteristic of 17 years old riders is over-confident which means that the riders have self-confidence in riding, but the riding skill is still unstable.

Based on Figure 3.2 and Table 3.2, the actual accuracy value is 77.59% which is lower than the perceived accuracy value of 51.11%, it means that the respondent's level of self-confidence is higher than what is actually experienced, then the error value is 26.48% that means the curve does not show well calibrated. This figure is much lower compared to 17 years old riders. So that, the characteristic of 17 years old riders is over-confident which means that the drivers have a self-confidence in riding, but the riding skill is still unstable.
Based on Figure 3.1 and Table 3.3, the actual accuracy value is 66.52% which is lower than the perceived accuracy value of 78.74%, it means the respondent’s level of self-confidence is higher than what is actually experienced, then the error value is 12.22% and the calibration curve almost well calibrated. This figure is much higher compared to 17 years old riders and 18 years old ones. So that, the characteristic of 17 years old riders is over-confident which means that the riders have self-confidence in riding, and the riding skill is still unstable but better than 17 years old and 18 years old riders.

The best comparison between actual accuracy and perceived accuracy is if the two values are balanced to form a well-calibrated curve. Of the three error values, it is known that the smallest error value is owned by 19 years old group, which is 12.22%, so the group has better riding characteristics than the groups of 17 and 18 years old ones. The error value also shows that 17 years old riders have higher level of confidence compared to 19 years old riders.

### 3.3 Result of Level of Awareness

The results of the level of awareness in each age group are presented in table 3.2:

| Age (Years Old) | Level of Awareness |
|-----------------|--------------------|
| 17              | 53.04%             |
| 18              | 41.15%             |
| 19              | 53.63%             |

Based on Table 3.2, 17 years old riders have 53.04% level of awareness, 18 years old ones have 41.15% level of awareness, and 19 years old riders have 53.63% level of awareness. The highest level of awareness is owned by 19 years old group. The level of awareness is still not at a safe level, the low value can be due to many traffic behaviors that are not good and tend to underestimate the risks that can harm the riders themselves and others.

Based on the results, 19 years old is better criteria to be the minimum age to have a driving license to reduce the number of accidents. According to [9], it is stated that age can influence safe driving behavior, but there are other factors including education, knowledge, and attitude. Thus, riders with high school education background still have an attitude of willingness to be cared for and mimic the behavior of other riders by riding the pace of the vehicle without considering the risk of accidents [10]. However, according to government regulations, 17 years old citizens can have a valid driving license.
even though they are still prone to traffic accidents. Thus, supervision from more experienced people to provide guidance and a good understanding of safe driving ethics as well as the provision of tools safety are necessary to minimize the risk of traffic accidents.

4. CONCLUSION

Based on the results, the comparison between the actual accuracy value and the perceived accuracy value for each age are as follows:

1. The actual accuracy value of age 17 is 62.96% and the perceived accuracy value is 80.48%, so the error value is 17.52%.
2. The actual accuracy value of age 18 is 51.11% and the perceived accuracy value is 77.59%, so the error value is 26.48%.
3. The actual accuracy value of age 19 is 66.52% and the perceived accuracy value is 78.74%, so the error value is 12.22%.

The characteristics of the riders of the three ages are over-confident, which means that the riders have self-confidence in riding, but the riding skill is still unstable. The level of awareness of 17-year-old motorcycle riders is 53.04%, 18-year-old riders is 41.15%, and 19-year-old riders is 53.64%. 19 years old is better and feasible to be minimum age of driving license to reduce the number of accidents.

5. REFERENCES

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