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Analysis of Situational Awareness for Online Taxi Bike Driver in Yogyakarta Using QUASA Analysis

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Abstract. *Online taxi bike service has its charm because it is a breakthrough for current conditions that make it easy for consumers to order a vehicle. Riding a motorcycle is an activity that requires awareness against dynamic road conditions that can change in seconds. This study aims to determine the level of awareness of online taxi bikes driver when using a GPS and non GPS. The method used in this research is the QUASA method, which combines the probing method in the situational awareness process with the self-rated method. The results of data processing obtained that the value of actual accuracy and perceived accuracy when an online taxi bike driver uses a GPS is higher than non GPS. In addition, other results stated that the level of awareness of online taxi bike drivers when using a GPS was 4.7% greater than when without non GPS.*

Keywords: *QUASA, situational awareness, online taxi bike service, signal detection theory, alertness level*

I. INTRODUCTION

Transportation is one of the main components in life, even in the government and society (Aminah, 2006). It became one of the main factors in developing whether economics, culture, or even politics in the country (Sutardi & Martina 2012). Therefore, any slightest problem in the transportation system could have a massive effect, which could lead to economic and social welfare problems (Kadarisman et al. 2015). The need to move freely yet as fast as we can, have changed the type and face of businesses model in the transportation section. Technology becomes the most disrupted point, even in the transportation model. With the rise of application-based business, even in transportation, it has become the most favorable point for customers compared to the old conventional means of transportation, such as conventional taxi drives on. Customers tend to choose application-based transportation compared to the old one because of its easiness. Moreover, they offer cheaper fare than the old one (Hariyatno et al., 2018).

On 2017, it was recorded that, there are at least 1.5 Million active users in Indonesia which known using the online taxi bike services (Bohang, 2017), thus it is shown that many people in Indonesia are started to find ease and comfort in using online transportation methods including the online taxi bike (Hariyatno et al., 2018).

The Indonesian government has already stated that every person who is riding any kinds of vehicles are obliged to drive the vehicle in a full concentration and a proper manner (Undang-Undang no 22, 2009, Pasal 106, Ayat 1), which means, that will be a problem for the online taxi bike drivers, that divert their attention to their gadget while checking the ordering status of their taxi bike account.

By the end of 2013, there has been at least a 168,174 road accident in Indonesia, and motorcycles are dominating most cases with 119.550 accidents (Djaja et al., 2016). Another report says that in ten years ranging from 2007 to 2016, The National Committee for Transportation Safety (KNKT) found that there are 64 traffic cases happened in Indonesia with 65,6 % or equals to 42 cases are collision type. (Saputra, 2017).

Driving is a strenuous activity that requires both physical and mental work, while the goal of

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driving itself is by going to another destination safely (Mustapha et al., 2016). Driving in the streets basically will increase the stress level of the driver (Schiebl, 2006), starting from the harsh environment (heat or even rain), the abilities of the driver itself, traffic condition, to unpredicted road condition will decrease the concentration of the driver. One of the main concerns while driving is the Situational Awareness (SA) of the driver. SA is a condition in which the driver could easily perceive the surrounding situation, and could easily detect what s/he must do in that condition (Endsley & Garland, 2000; Endsley, 1995; Endsley, 1993). According to the situational awareness model in driving, we could break down the level into 3 (Michon, 1985; Bernotat, 1970; Rasmussen, 1983;), namely: operational, tactical, and strategic. To survive the unstable condition on the road, drivers need to understand the three-level of SA fully. Drivers should and have to focused on their primary activity, which is driving. Any additional secondary task performed concurrent with the primary driving task, might decrease the result of the driving performance (Schomig & Metz, 2013).

One of the methods to measure and evaluate the level of Situational Awareness is "Quantitative Analysis of Situational Awareness" or QUASA. QUASA is a combination of several evaluation methods in situational awareness; it combined the probing technique in the classical situational awareness and added the self-rated process of which the drivers answer (McGuiness, 2004). This method is done by giving queries or questions regarding the condition while driving, including the True/False items, to find out how sure the drivers have their answers (McGuiness, 2004).

II. RESEARCH METHOD

This research was conducted in two major ways, and the first method was collecting the respondents' demographics data. The respondents of this research are the online taxi bike drivers in Yogyakarta. Following the demographics questionnaire, the next step of the study is the QUASA questionnaire, which will be distributed to the same respondents, which are the online taxi bike drivers.

The Demographics questionnaire contains the questions related to the driver's experience regarding their skills, while the second questionnaire, QUASA, contains the items of the situational awareness condition of the drivers.

Using the demographics data which is collected from the questionnaire, the route of the simulation for the situational awareness test is determined. There will be two (2) models of simulation, and the first is asking the drivers to use the online map (application) while driving, while the second one asks drivers to operate without the online route.

Based on the data from the QUASA questionnaire, the data will then be processed with several tools to find how the level of the SA of the respondent on both models mentioned above.

III. RESULT AND DISCUSSION

Research Overview

This research was conducted in Yogyakarta, with 30 online taxi bikes drivers as it's respondent. The drivers will first be briefed about the current study, including the model of the research, the questionnaire that should be filled, and the route that should be taken. This research is not limiting in several companies in a taxi bike driver, but the time of which the data were taken, will be specified to prevent any misinterpretation of the data.

Two questionnaires being used in this research, namely: a) Demographic Questionnaire, b) QUASA Questionnaire. The demographic questionnaire is being used to find personal data, including their length of time is an online taxi bike driver. Use this questionnaire, and the researchers then determine the route of the experiment that will be used in both models. The route of the experiment itself will take 31 minutes or equals to 11 km, and it is shown in Figure 1.

The route created shown in Figure 1, the QUASA questionnaire then being used in two models. This model is chosen by the researcher to compare both situations that being

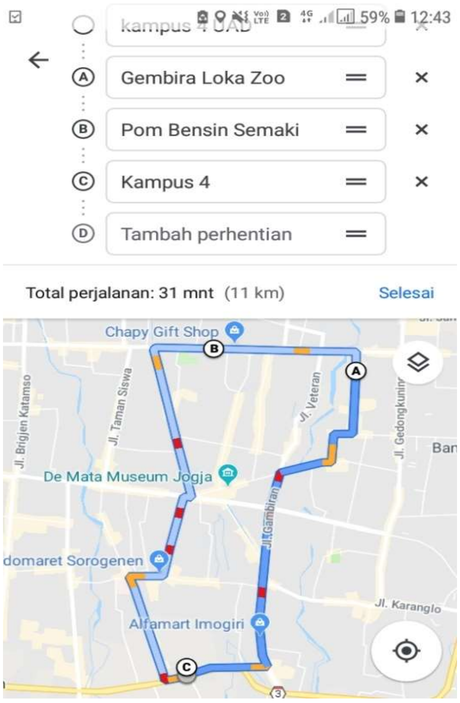

Figure 1. Route of the Simulation

implemented to the respondent. The two (2) conditions that being compared are namely: a) GPS situation b) Non-GPS situation. In the first simulation model, the respondent needs to follow the instructions given by the GPS entirely; along the way, the respondent will be asked with several questions related to the current situation in the road. The items will be used as a gauge of the driver on how high their SA level. The research itself will only use two (2) levels of SA, namely: Perception and Comprehension. The second model or the non-GPS situation is having the same treatment and route regarding the simulation. The significant difference between the first and second models is the absence of GPS. Drivers need to go to the same main goal, without the assistance of the GPS.

Using the second data collected from the QUASA questionnaire, researchers are going to classify the level of the SA by using the Signal Detection Theory (SDT). SDT is a model that illustrates how a person doing their task based on the stimuli they receive (McGuiness, 2004). SDT classify the probability of responses that someone had when doing several jobs, namely: hit, false alarm, miss, or correct rejection (McGuiness, 2004)

The main goal of this research is concerning and finding the difference between using GPS while driving and not using GPS for online taxi bikes drivers.

Calibrating the Situational Awareness

Several steps need to be done in this research to obtain the primary goal. The first step is by doing the Calibration in Situational Awareness. This step is used to find the comparison between actual accuracy and perceived accuracy. Based on the model that is created, there will be 2 types of confidence levels that will be shown in Table 1 and Table 2.

The confidence level shown in Table 1, will be the perceived accuracy of the drivers. To find the comparison between the actual and perceived accuracy, we need first to use the mathematical formula shown in Eq. (1).

$$\sum \text{Score} = \sum \text{Questions X} \sum \text{Respondent X } 100\% \quad ...(1)$$

Using (1), thus we could find the total score answered by the respondent

Table 1. Confidence Level without GPS Scenario

Resp.	Confidence Level	Resp.	Confidence Level
No. 1	19	No. 16	0
No. 2	14.6	No. 17	20
No. 3	16.8	No. 18	20.8
No. 4	15.4	No. 19	21
No. 5	15.2	No. 20	19.8
No. 6	15	No. 21	21.6
No. 7	12.4	No. 22	21.4
No. 8	15.4	No. 23	19.8
No. 9	19.4	No. 24	22
No. 10	17.4	No. 25	20
No. 11	14	No. 26	21.2
No. 12	17	No. 27	19.8
No. 13	15.8	No. 28	21.2
No. 14	16.2	No. 29	19.6
No. 15	14	No. 30	0

Table 2. Confidence Level with GPS Scenario

Resp.	Confidence Level	Resp.	Confidence Level
No. 1	15.2	No. 16	0
No. 2	13	No. 17	21
No. 3	15	No. 18	20.8
No. 4	19	No. 19	21.2
No. 5	16	No. 20	18.8
No. 6	15.8	No. 21	20.6
No. 7	15.8	No. 22	20.8
No. 8	15.2	No. 23	21.4
No. 9	14.6	No. 24	21.6
No. 10	18.4	No. 25	20.2
No. 11	18.2	No. 26	20.4
No. 12	15	No. 27	20.4
No. 13	18.2	No. 28	21.6
No. 14	18.2	No. 29	21
No. 15	15.4	No. 30	0

Total Score (1st Scene) = 22X 30X100%
= 660

While both Actual and Perceived Accuracy can be found using the mathematical formulation shown in (2) and (3)

Actual Accuracy =

$$\frac{\sum \text{Questions Answered Correct}}{\sum \text{Score}} X\ 100\% \quad ....(2)$$

Perceived Accuracy =

$$\frac{\sum Confidence\ Level}{\sum Score} X\ 100\% \quad ....(3)$$

Using (2) and (3), we could find both scores shown below.

Actual Accuracy = $\frac{353}{660} X\ 100\%$
= 0.5348 ≈ 53,48%

Perceived Accuracy = $\frac{506,4}{660} X\ 100\%$
= 0.7672 ≈ 76.72%

Following the first model, the next step that should be done is finding the comparison in the second model, namely the "GPS Simulation" model. The same steps done in the previous model, it is shown in Table 2, regardless of the confidence level of the respondents while doing the simulation.

Table 2 shown the perceived accuracy of the respondents, but in the second model, which the respondents are guided by the GPS to finish the

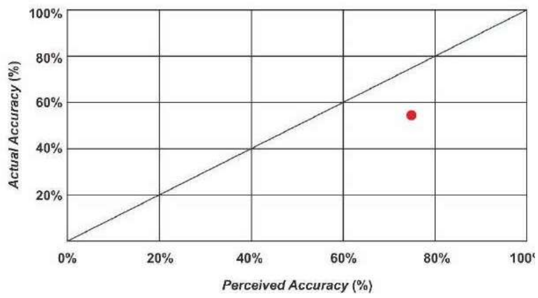

Figure 2. Calibration Curve of Non-GPS Scenario

simulation. Using (1), (2), and (3), we could find the comparison between both actual and perceived accuracy of the second model.

Total Score (2nd Scene) = 660

Actual Accuracy = $\frac{397}{660} X\ 100\%$
= 0.6015 ≈ 60.15%

Perceived Accuracy = $\frac{512.8}{660} X\ 100\%$
= 0.777 ≈ 77,7%

Following both results, we could proceed to the next step, which is finding the situation of the Situational Awareness of the respondents by calibration based on the results. The calibration is finding how far the persons could decide the truth based on their observation or decision (McGuiness, 2004). Put it simply, the calibration process is a method to find a conformity between their actual accuracy and self-perception/perceived accuracy (Koriat & Goldsmith, 1996). The Calibration process is divided into two (2) significant regions, namely: a) Over-Confident Condition b) Under-Confident Condition (McGuiness, 2004). Based on the research's results on both models shows us, that the drivers are in over-confident conditions, which means that drivers tend to believe that they have correctly answered the questions or could comprehend the current situation, but in contrast, most of the answers were not right; hence drivers are in over-confident condition, which is shown in both Figure 2 and Figure 3.

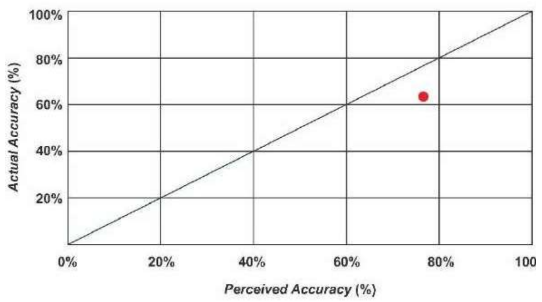

Figure 3. Calibration Curve of GPS Scenario

Over-Confidence condition is a situation in which the calibration point/dot, falls below the calibration line. On both cases, it indicates that drivers in both simulation models could not fully understand their surrounding, yet believing that what they have done are correct. This kind of condition is a problem in a driving situation, which could lead to a fatal accident due to their negligence on the road.

Alertness Level

Alertness level refers to how a driver's cognition while driving on the road. Based on the three-level of SA (Endsley, 1995), we could relate the alertness level with how their attitude while driving. Alertness level can be found by multiplying the confidence level answer with the correct answer, shown in (4)

$$Alertness\ level = \frac{Confidence\ Level\ X\ Correct\ Answers}{\sum Total\ Score} \quad \ldots (4)$$

Based on (4), it is imperative to know the score of the confidence level multiplied by the correct answers, shown in Table 3 and Table 4.

Based on Table 3, and using the formulation on (4), we could determine the alertness level of the drivers in the first scenario model.

Alertness Level (Non-GPS Scene)

$= \frac{304.6}{660} = 0.4615 \approx 46.15\%$

Based on data shown in Table 4 and the formulation on (4), we could find the alertness level in the GPS Scenario (second scenario model).

Alertness Level (GPS Scene)

$= \frac{335.6}{660} = 0.5085 \approx 50.85\%$

Table 3. Confidence Level Multiplied by Correct Answers in Non-GPS Scenario

Resp.	Confidence Level Multiplied	Resp.	Confidence Level Multiplied
No. 1	10.2	No. 16	0
No. 2	8.8	No. 17	15.4
No. 3	9.4	No. 18	14.2
No. 4	6	No. 19	12.6
No. 5	7	No. 20	13.8
No. 6	11.4	No. 21	14.8
No. 7	6.2	No. 22	14.4
No. 8	8	No. 23	15.4
No. 9	9	No. 24	16
No. 10	10.8	No. 25	11.2
No. 11	8.4	No. 26	13
No. 12	10.4	No. 27	10.8
No. 13	10.2	No. 28	13.6
No. 14	6.4	No. 29	10.4
No. 15	6.8	No. 30	0
		Score	304.6

Table 4. Confidence Level Multiplied by Correct Answers in GPS Scenario

Resp.	Confidence Level Multiplied	Resp.	Confidence Level Multiplied
No. 1	10.2	No. 16	0
No. 2	7.6	No. 17	13.6
No. 3	7.4	No. 18	15.2
No. 4	13	No. 19	14.2
No. 5	8.8	No. 20	12
No. 6	9.6	No. 21	13
No. 7	11	No. 22	11.8
No. 8	9.4	No. 23	14.6
No. 9	8.4	No. 24	14
No. 10	13.8	No. 25	12.8
No. 11	14	No. 26	12.6
No. 12	8	No. 27	15.4
No. 13	12.4	No. 28	15.6
No. 14	15.6	No. 29	14.2
No. 15	7.4	No. 30	0
		Score	

Following the result of the Alertness level on both models, surprisingly, drivers had a higher alertness level while driving in the GPS model rather than without the GPS. Although insignificant, the difference in the Alertness level on both models shows that driving while using GPS requires a higher cognitive level to avoid accidents; thus, the GPS Scenario provides a higher alertness level.

Signal Detection Theory (SDT)

Signal Detection Theory (SDT) shows how accurate a person could describe and analyze the current task given (McGuiness, 2004). It is also to find how good the persons could distinguish a stimulus given to them. The better the persons to detect the incentives, the lower their "miss rate." SDT could be quickly breakdown into 4 phase, that is shown in Figure 4.

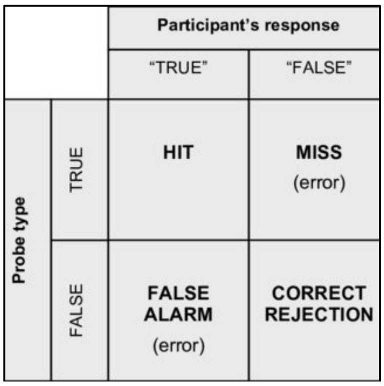

Figure 4. Signal Detection Theory Model (McGuiness, 2004)

Using the SDT model shown above, we could find the SDT level on both models, ran in this research. Using the formulation shown in (5), (6) (7) and (8), we could find the "Hit Rate," "Miss Rate," "False Alarm Rate" "Correct Rejection Rate" in SDT.

$$Hit\ Rate = \frac{\sum Right\ Answers\ being\ Answered\ Correctly}{\sum Questions\ Answered\ Correctyly\ X\ \sum Respondent} \quad ...(5)$$

$$Miss\ Rate = 1 - \text{hit rate} \quad ...(6)$$

$$False\ Alarm\ Rate = \frac{\sum Wrong\ Answers\ being\ Answered\ Correctly}{\sum Questions\ Answered\ Falsely\ X\ \sum Respondent} \quad ...(7)$$

$$Correct\ Rejection\ Rate = 1 - \text{False Alarm Rate} \quad ...(8)$$

Based on the formulation written in (5), (6), (7), (8), we could predict the "Hit Rate," "Miss Rate," "False Alarm," and the "Correct Rejection Rate" in both models. The first result is the Non-GPS Model shown below.

Hit Rate Probablity (Non-GPS) = $\frac{197}{12X30}$ = 0.55

Miss Rate Probability = 1- Hit Rate = 1 – 0.55 = 0.45

False Alarm Rate = $\frac{122}{10X30}$ = 0.41

Correct Rejection Rate = 1-False Alarm Rate = 0.59

Following the formulation that have been found, we could create the contingency table in SDT, shown in Figure 5.

Using the same formulation in (5),(6), (7), and (8), we could then proceed to find the SDT for the second model.

Hit Rate Probablity (GPS Scenario) = $\frac{258}{12X30}$ = 0.72

Miss Rate Probability = 1- Hit Rate = 1 – 0.72 = 0.28

False Alarm Rate = $\frac{139}{10X30}$ = 0.46

Correct Rejection Rate = 1-False Alarm Rate = 0.54

Based on the formulation shown above, we could create the contingency table in SDT for the second model shown in Figure 6.

Using both SDT tables, we could proceed

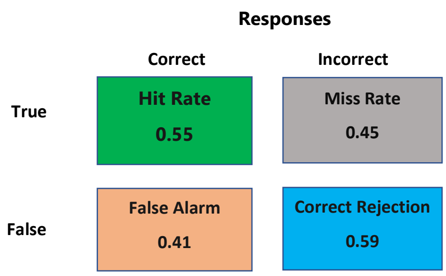

Figure 5. Contingency Table for Non-GPS Scenario

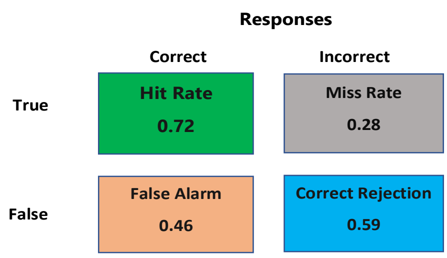

Figure 6. Contingency Table for GPS Scenario

into the next step of the Situational Awareness analysis. Sensitivity (d') shows how a person could distinguish between signal and noise in the SA condition. Sensitivity point is affected by bias responses, assumed these two conditions are fulfilled, namely: a) Signal and Noise are normally distributed b) both signal and noise have the same standard deviation (Stanislaw & Natasha, 1999), if one or both conditions are not fulfilled, the sensitivity point will not be affected by the bias responses. The Sensitivity Analysis for both scenarios is shown in Figure 7 and Figure 8.

Non-GPS Sensitivity Analysis Scenario

H0 = respondent could distinguish the signal
H1= respondent could not distinguish the signal
α = 10%
d′ = Z (Hit) – Z(False Alarm)
= Z(0.55) – Z(0.41) = 0.13 – (-0.22) = 0.45

Based on the formulation, we could plot it in the cartesian table, shown in Figure 6.

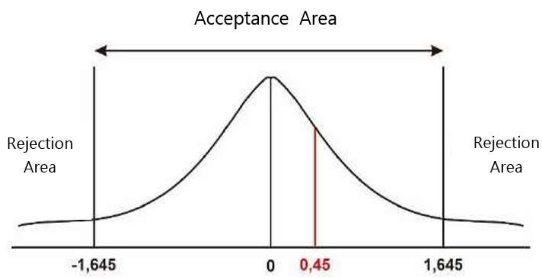

Figure 7. Sensitivity Analysis for Non-GPS Scenario

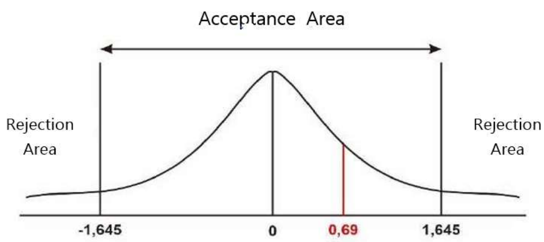

Figure 8. Sensitivity Analysis for GPS Scenario

Figure 7 shows that the sensitivity score is between the rejection area. Therefore we could assume that drivers could distinguish between noise and signal given in the simulation.

Following the Non-GPS scenario for the sensitivity analysis, we could create the same sensitivity analysis for the second model/GPS Scenario.

GPS Sensitivity Analysis Scenario

H0 = Respondent could distinguish the signal
H1 = Respondent could not distinguish the signal
α = 10%
d′= Z (Hit) – Z(False Alarm)
= Z(0.72) – Z(0.46) = 0.59 – (-0.10) = 0.69

Based on the formulation, we could also plot the result in the cartesian table, shown in Figure 8. Figure 8 shows that the sensitivity score is between the rejection area. Therefore we could assume that drivers could distinguish between noise and signal given in the simulation.

Although there is no significant result in both model, surprisingly, the GPS scenario shows us that drivers could distinguish both signal and noise better (0.69 to 0.45), rather than the non-GPS scenario, which means, driving while following the instructions from the GPS will increase their concentration and SA condition.

IV. CONCLUSION

Most of the online taxi bike driver in this research, are in an over-confident region (shown in Figure 2 & Figure 3), which means that most of the drivers are thinking that they have ridden in a right manner and could understand the route and also could comprehend the current situation on the street, while in fact, they are not driving in a proper way. Surprisingly, the alertness level of the second model (GPS Scenario), shows that drivers tend to have higher alertness level (50.85%), although not much difference with the non-GPS level (46.15%). This model could prove that somehow drivers tend to be more focused while using their online map/GPS. Another note to take is that most of the drivers' SDT analyses are in the "hit" region, showing that even the drive could still understand their surroundings and could comprehend the current situation. Based on the SDT analysis, we could find the Sensitivity Analysis. It is found that both models show that drivers could distinguish between signal and noise. However, the GPS model provides a higher sensitivity level (0.69 to 0.45), which means drivers are more capable of identifying the noise while using the GPS.

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