ISSN : 1978-774X

WARNING DISPLAY DESIGN FOR THE TRANSJAKARTA BUS COCKPIT TO MINIMIZE THE DRIVER'S ERROR BEHAVIOR

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ABSTRACT

Operation of TransJakarta Busway was still face many problems, especially the high rate of accidents involving the driver. Most of the accidents was caused by lack of disciplined road users, errors, and omissions of the driver. the biggest factor causing driver negligence of regulations was the lack of warning signs attribute (display) that supports the regulations made by the company, in the percentage of 83.34%. Then a next study has been conducted using questionnaire to determine the need of display in the driver's work area. The objective of this study is to design the warning display int the cockpit of Transjakarta bus to minimize the driver's error behavior. The deep analysis resulted three kind of warning display that should be provided to minimized the error. There were velocity warning, Prohibition of cellular phone usage, and prohibition of sudden braking. Based on the results of the implementation, it was found that the observed error frequency based on the driver activities performed during driving, decreased after a given display design. For warning signs regarding maximum limit of vehicle, frequency of errors decreased by 26.67%, for a ban on driving while using a mobile phone is also decreased by 30%, and the last to ban the brake pedal suddenly / less careful is as much as 36,66%. This shows that the design of warning signs / displays that have been proposed could reduce the risk of human error on the TransJakarta

Keywords*: human error, display, design, public transportation.*

1. INTRODUCTION

According to Indonesian National Committee on Transportation Accidents (NCTA), 73% of transportation accident was caused by human error. Transjakarta Busway is a bus rapid transit service in Jakarta, Indonesia operated by the consortiums of PT. Transjakarta Busway. Transjakarta Busway has served 14 busway corridors since January, 15th 2014. Corridor 2 serves Pulogadung - Harmoni route, while corridor 3 serves Kalideres - Pasar Baru route. PT. Transjakarta Busway noted that 17% of accident was occurred on corridor 2 and 3. This was the highest percentage among all corridors operated by Transjakarta Busway.

Azmi et.al (2014) stated that since starting operations in 2004, the operation of TransJakarta Busway was still faced many problems, especially the high rate of accidents involving the driver. Most of the accidents wascaused by lack of disciplined road users, errors, and omissions of the driver.

The former study concluded that there were driver factors could cause an accident.The first was drunk driver. It was the condition of the loss of consciousness due to the influence of alcohol or narcotics. Second factor was fatigue or overly tired. Driver drives the vehicle in a state of fatigue or drowsiness due to lack of rest. This resulted in less vigilant and less agile to react to the changes that occur during the trip.

The third factor was emotional or distracted driver. In this condition, driver could daydream and not concentrate. They often did smoking, talking on the cellphone or texting while driving. The fourth was

unskilled driver. In this condition, driver could not predict the situation around the vehicle, sometimes loosing ability to braking, to keep a distance with the vehicle in front of the driver, and so on.

Based on data from the Government of Jakarta in 2012, the number of accidents on Transjakarta buses had increased significantly. The data showed that the rate of accidents in the Transjakarta lane was still quite high. Last few years data recorded 264 accidents in 2009, 246 accidents in 2010, and in 252 accidents 2011. Factors that affect traffic accident according to Hobbs (1995), are:

a. Human factors
b. Vehicle factors
c. Road and environmental factors

According to Department of Transportation of Republic of Indonesia, 93.52% of accidents are caused by driver factors unsuspecting, sleepy, unskilled, drunk, high speed, pedestrian error, and disturbance of animals. Preliminary research was conducted using a checklist on 15 drivers of corridor 2 and 3 have found facts that:

a. 76.67% of drivers was driving the bus at speeds exceeding 50 km/h
b. 70% of drivers was using a mobile phone when driving
c. 66.67% of drivers did sudden braking
d. 56.67% of drivers stopped the bus at a distance exceeding 15 cm from the edge of the door stop
e. 16.67% of drivers was driving the bus in a condition of sleep deprivation

Based on the results of the questionnaire, it was known that the biggest factor causing driver negligence of regulations was the lack of warning signs attribute (display) that supports the regulations made by the company, in the percentage of 83.34%. Then a next study has been conducted using questionnaire to determine the need of display in the driver's work area. The objective of this study is to design the warning display int the cockpit of Transjakarta Bus to minimize the driver's error behavior.

2. THEORETICAL BACKGROUND

According to Peters (2006), human error is the standard deviation of the predetermined performance, causing a delay due to the difficulties, problems, incidents, and failure.

Human error can occur due to many factors such as:

a. Induced Human Error System, in which the mechanism of a working system that allows workers to make mistakes. For example, the absence of a good discipline on the part of management
b. Induced design of human error, the errors resulting from design errors poor working system
c. Pure human error, when the error was coming from the man himself. For example, because of the ability and limited work experience.

Dekker (2002) on Hansen et.al (2006) differentiated between an old view human error as the cause of a mishap and an new view of human error as a symptom of externalizations acting upon a human being in a specific situation.

According to Gkouskos et.al (2014), there are nineteen driver's need dimensions: Automation, Calmness, Comfort and convenience, Connectivity, Control, Driver support, Trip context, Driving pleasure, Efficiency, Environmental impact, Freedom of choice, Interaction fluency, Ownership, Personalization, Safety, Self-image, Simplicity, Technology, and Versatility. They also point towards larger issues: e.g., how the control over driving should be distributed between the car, the driver, and/or a larger system; the car as a multi-tool instead of "just" a means of transportation; and, lastly, the car as being a connected part to a greater whole. Addressing these dimensions and the issues they point towards may be the difference between creating a one-size-fits-all vehicle into providing a more customized, personal, and potentially more positive user experience.

Steenken et.al (2014) used the fixed-based driving simulator in the experiment as shown in figure 1.

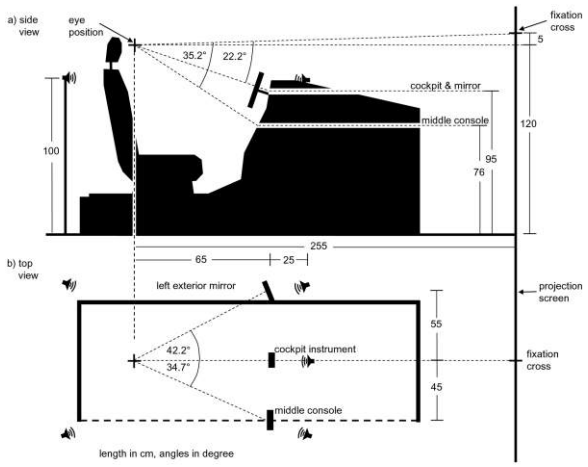

Figure 1. The Fixed Based Driving Simulator

The Steenken driver's work place condition was used in this research, especially on the optimal sight degree on the cockpit.

3. RESULT AND DISCUSSION

The error description and the effect of error is shown on the table 1 below.

Table 1. Driver's Error Behavior Description

No. Task	Error Behavior Description	Result of Error
1	Driver does not check the engine and the brake before driving.	Bus mogok, kebakaran karna kerusakan pada mesin, rem blong
2	Driver does not check the function of pneumatic door button.	The door might be broken
3	Driver does not check the tire condition.	The tire might be broken, and the trip might be disturbed
4	Driver does not bring the fire cease tool on the bus	When there is fire on bus, there would be no emergency tools to safe the condition
5	Driver drove over 50 km/hour	Accident could be happened or sudden braking could be more possible
6	Driver used cellular phone while driving	Accident
7	Driver was speeding when heading the shelter	Distance between bus door and shelter platform could be too far to jump up by the passenger
8	Driver parked the bus far from the shelter platform.	Passenger felt down when entering or going outside the bus.
9	Driver does not notice the flow of the passenger from and to the shelter	Passenger could be left behind or the bus cabin could be overloaded
10	Driver was doing procrastination on the resting time.	Delay on bus departure
11	Driver was late to do the shift exchange	Bottleneck in the passenger queue

Then a questionnaire was released to find the reasoning of the driver's error behavior. 83,34% of respondent stated that the primary factor resulting on the driver's error behavior was the lack of display of warning that containing the information of the rules. 80% of respondent agreed that there was a need of display design to minimized the error behavior.

The demographic analysis showed that 96.6% of all the Transjakarta drivers were male, 43.33% were 31-40 years old, 100% were all literate with the work experience of 3-6 years as a bus driver. Among 80% of driver had to wear glasses. Then the deep analysis resulted three kind of warning display that should be provided to minimized the error. There were velocity warning, probihition of cellular phone usage, and prohibition of sudden braking.

Color selection is the speed limit on a display in accordance with ISO standards that have been there before. Writing color used is black with a white background to make it look more contrast for the highest luminescent in black color while the lowest luminescent is white.

Selection display for a mobile phone that is in accordance with the existing ISO standards, where to display that indicates a danger of using a red background, so that the resulting display becomes more interesting and sentence writing messages on the display can be read clearly.

Display a warning sign to prohibit sudden brake in accordance with ISO standards exist that indicate where to display a warning to use a yellow background, so that the resulting display becomes more interesting and sentence writing messages on the display can be read clearly.

The generic step of product design was used in this research. The first step was to identify the need of respondent. Mission statement was constructed to describe the warning display that would be created. Then brainstorming was done to find the attribute of the display. The attribute were picture on the display, message sentence, color, layout, font style, dimension of display, font dimension, and material.

To decide what the most important attribute must be provided in the display design, the Entropy method was used. The weight of each attribute is shown in the table 1.

Table 1. Entropy Value of the Display Attribute

No	Display Attribute	Entropy Value
1	Picture on the display	0,1592
2	Message sentence,	0,1809
3	Color	0,1636
4	Layout	0,1565
5	Font style and dimension	0,1809
6	Material	0,1592

Some alternatives of display were given to respondents. Then all the respondents were asked about their preferences on the brainstorming meeting. From the results of the questionnaire, it can be concluded that the respondents desired text for display are: display of speed limit used Rockwell Extra Bold with a percentage of 60%, while for the warning display of cell phone use kind of font Rockwell extra Bold with a percentage of 80%, and for the warning display of sudden braking used type of writing Bookman Old Style with a percentage of 60%.The display design chosen by the respondent is shown on Figure 2, 3 and 4.

Figure 2. Velocity limit warning display

Figure 3. Cellular Phone Usage Warning Display

Figure 4. Sudden Breaking Display

According to Bridger (1995), the visual area for the placement of an object is 15 degrees up, down, left, and right from the eye parallel to the ground. The design of the display is calculated based on the height of driver in a sitting position with a height of 110 cm. The distance from the farthest visual display was 1500 mm. Then the maximum visibility was 1500 * tan 15^{o}= 405mm = 4,05 m.

Evaluation of the display design that has been implemented on TransJakarta-Busway Corridor 2 and Corridor 3 evaluation was conducted using questionnaires. The evaluation was conducted to determine the level of understanding of of the driver to the warning signs that have been designed, the suitability of images and words used and the typeface used. Respondents were considered to have understood the information in the displays.

4. CONCLUSION

Based on the evaluation results show that the display has been designed can be well understood by the workers. Based on the results of the implementation, it was found that the observed error frequency based on the driver activities performed during driving, decreased after a given display design. For warning signs regarding maximum limit of vehicle, frequency of errors decreased by 26.67%, for a ban on driving while using a mobile phone is also decreased by 30%, and the last to ban the brake pedal suddenly/less careful is as much as 36,66%. This shows that the design of warning signs/displays that have been

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ACKNOWLEDGEMENT

The content of this paper is a part of an University Leading Research (Penelitian Unggulan Perguruan Tinggi) decentralization research grant funded by Private Higher Education Coordinating (Kopertis) Region III, Ministry of Education, 2014, no of agreeement : 183/A/LPT/USAKTI/V/2014.

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