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Analyzing Bus Driver's Behavior With Fuzzy Method

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ABSTRACT

Background: Bus drivers are commonly known as reckless in driving. Their behavior often causes traffic accident. We offer a solution for this matter, named as the black box, which is intended to identify the dangerous behavior of the driver while driving the bus as a form of public transport. **Objective:** The research is intended to classify bus driver's behavior of using black box facility, black box used in this study using warning lamp and without warning lamp.**Method:** The model applied to classify the driver's behavior is Sugeno fuzzy logics, data input covering brake, speed, sign lamp, seat belt, steer, and driver's identity: age and education. The research involves 8 bus drivers whose route at a range around 240 km or about 1 hour trip.To determine the average speed of each driver while driving the bus within the city was measured using the driving time.it was around 15 minutes of each driver so that the total time to collect the data for all drivers was around 900 second.**Results:** The findings of the research show that black box is able to record driving data in detail and real time. **Conclusion:**The classification of driver's behavior indicates that driver at young age with low educational background shows dangerous behavior while driving the public transport, whereas driver at old age with middle educational background is careful driving. It very urgent to determine the regulation about the installation of black box and black box with warning lamp in bus because the function of black box is very important.

INTRODUCTION

Identification on dangerous driving of bus driver is done manually now, in which passengers just warn the driver when the driver drives the bus in high speed or just reports to the company about the dangerous behavior of bus driver. This strategy is not effective anymore. Driver's recklessness is the main factor to cause traffic accident, it is indicated by inpatient driving and driving in high speed (Houston *et al*., 2003; James *et al*., 2000;Sjorberg *et al*., 2004; Tasca, 2000). Many researchers already design black box for transportation (Lee *et al*., 2007; Nikhil and Milind, 2011) to improve the driving safety on the road or high way.

Black box is installed in bus as a mean to gain data such as brake, steer, sign lamp, seat belt, speed, and driver's identity: age and education. Output is driver's behavior such as careful driver, reckless driver, and very reckless driver. Process of data analysis used Sugeno fuzzy logic since this model is appropriate to solve the problem of input variable from bus instrument. There are many studies that implement fuzzy logic on driver's behavior (Imkamon *et al*., 2008; Toshihisa and Motoyuki, 2012). Some researchers already used black box and driver's behavior (Han *et al*., 2009; Masaru and Sumio, 2006; Ricardo *et al*., 2012; Toledo *et al*., 2006; Lee and Cho, 2007). The research is intended to know the classification of eight bus drivers to compare the behavior of each driver such as the behavior of bus driver without black box, with black box, and with black box and

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warning lamp.

The research involves 8 bus drivers whose route at a range around 240 km or about 1 hour trip, while driving the bus within the city was measured using the driving time. it was around 15 minutes of each driver so that the total time to collect the data for all drivers was around 900 second.

The findings of the research show that black box is able to record driving dataof brake, steer, speed, sign lamp, and seat belt in detail for bus as a mean of public transport so that when the accident happens, the reason of accident can be investigated accurately.

The classification of driver's behavior indicates thatdriver at young age with low educational background shows dangerous behavior while driving the public transport, whereas driver at old age with middle educational background is careful in driving.It very urgent to determine the regulation about the installation of black box and black box with warning lamp in bus because the function of black box is very important.

Research Methods:

The study was conducted in Situbondo until Surabaya at a distance of around 240 km. The process to collect the data started from October-December 2014 on economic standard bus. The process of data analysis was done at transportation laboratory of Civil Engineering of University of Brawijaya. Method of data collection used black box facility that was installed in bus. Black box installation as presented in Fig.1, 2, and 3 as follows:

Fig. 1: Steer Sensor

Fig. 2: Speed Sensor

Fig. 3: Brake Sensor

The research was intended to detect the driver's behavior per second while driving the bus, in this case, each driver was driving the bus at range 80 km for each treatment such as driving the bus without black box, driving the bus with black box, and driving the bus with black box and warning lamp. To determine the average speed of each driver while driving the bus within the city, the researcher used the period of around 900 second. Indicator to determine whether green warning lamp, yellow warning lamp, or red warning lamp was on or not was the speed of each driver while driving the bus (Table 1).

Table 1: Indicator of Driver's Speed

Speed (Km/hour)	Classification	Warning lamp is on
0-80	Careful	Green
81 – 109	Reckless	Yellow
>110	Very Reckless	Red

Model of fuzzy logic used in this research was Sugeno fuzzy logic in which the data was gained through black box instrument. Input variable for this research includes brake, steer, sign lamp, seat belt, speed, and

driver's identity: age and education. Variable of driver's identity is available as follows:

Driver 1: Age 34 year, education junior high school
Driver 2: Age 46 year, education junior high school
Driver 3: Age 48 year, education junior high school
Driver 4: Age 56 year, education senior high school
Driver 5: Age 50 year, education primary high
Driver 6: Age 52 year, education junior high school
Driver 7: Age 31 year, education primary high
Driver 8: Age 32 year, education junior high school

The description of analysis process of Sugeno fuzzy logic is available in figure 4 as follows:

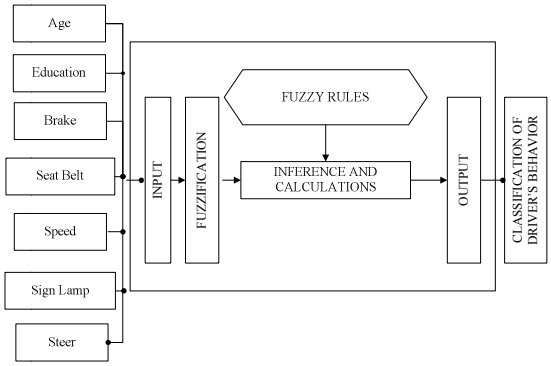

Fig. 4: Scheme of Fuzzy Logic

Method of Sugeno Fuzzy Logic:

Method used in this research was Sugeno fuzzy logic Orde-Nol model, and the description of the model is as follows:

IF (x1 is A1) • (x2 is A2) • (x3 is A3) •
(x4 is A4) • (x5 is A5) THEN z = k (1)

Note:

x1= Speed, x2=Steer, x3 =Brake, x4= Sign lamp, x5=Seat Belt.

A1 (slow, fast, and very fast), A2 (small angle, middle angle, and big angle), A3 (not stepping brake, moderately stepping brake, and fully stepping brake), A4 (warning lamp off and warning lamp on),

Z= Driver's behavior

K= 1 (Careful), 2 (Reckless), and 3(Very Reckless)

While theidentity of the driver, include:

x6=Age, x7=Education

A6 (teenager, young, adult, and old), A7 (low, secondary, high, and higher)

RESULTS AND DISCUSSION

The process of collecting the data is presented in Fig. 5. It shows that green warning lamp was on, meaning that the driver's speed was below 80 km. Black box was equipped with a switch that functions to turn on and off black box and warning lamp to make it easier to collect the data.

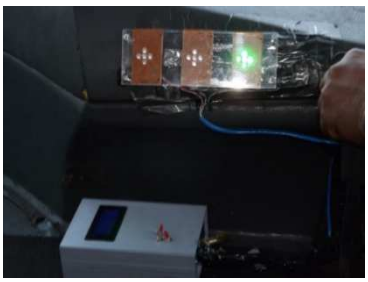

Fig. 5: Data Collection Process on Bus

The research findings of driver's behavior classification on driver without black box, driver with black box, and driver with black box and warning lamp determined the level of carefulness of each driver, and are described in Figure 6 as follows:

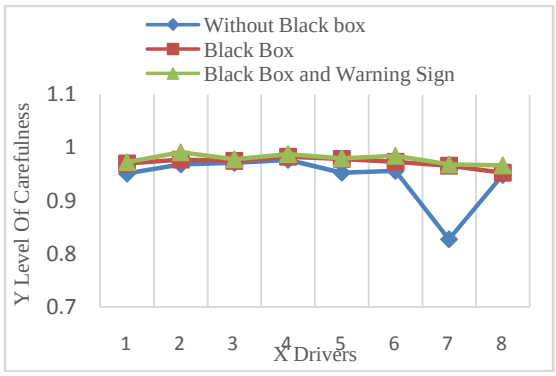

Fig. 6: The Level of Carefulness of Each Driver

Driver without black box is classified as driver with very low carefulness; driver with black box and warning lamp is classified as driver with very high carefulness. The driver at young age or teenager driver with low educational background is classified as driver with very low carefulness. Whereas, driver at old age with senior high school educational level is classified as driver with very high carefulness.

To determine the average speed of each driver while driving the bus within the city was measured using the driving time; it was around 15 minutes of each driver so that the total time to collect the data for all drivers was around 900 second. The average speed of each driver while driving the bus within the city is presented in Figure 7 below:

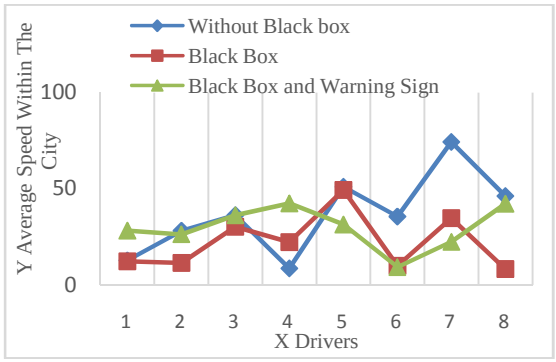

Fig. 7: The Average Speed of Driver while Driving Bus public within the City

The average speed of driver without black box while driving bus within the city was classified into dangerous driving speed. Driver with low educational background and at old age was classified as to have dangerous driving speed. Driver at young age and junior high school educational level was classified to have dangerous driving speed. The average driving time was classified into careful driving speed.

Conclusion:

The research findings show some points as follows:

1. Black box and black box with warning lamp are significantly able to record data of brake, steer, speed, sign lamp, and seat belt in detail for bus as a mean of public transport so that when the accident happens, the reason of accident can be investigated accurately.
2. Driver's behavior is generally classified into careful behavior; but for the average speed of the driver while driving bus within the city, driver without black box is classified to have reckless dangerous behavior.
3. The classification indicates that driver at young age with low educational background tends to be reckless to drive the bus within the city, while the driver at middle age with middle educational background tends to be careful to drive the bus.
4. It very urgent to determine the regulation about the installation of black box and black box with warning lamp in bus because the function of black box is very important.

Suggestion:

1. The research on using black box in bus can be duplicated with bigger number of buses and drivers.
2. It very urgent to determine the regulation about the installation of black box and black box with warning lamp in bus because the function of black box is very important.

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