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To cite this article: A Suraji *et al* 2017 *IOP Conf. Ser.: Mater. Sci. Eng.* **267** 012026

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Driver Performance Problems of Intercity Bus Public Transportation Safety in Indonesia

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Abstract. The risk of an inter-city bus public bus accident can be influenced by various factors such as the driver's performance. Therefore, knowing the various influential factors related to driver's performance is very necessary as an effort to realize road traffic safety. This study aims to determine the factors that fall on the accident associated with the driver's performance and make mathematical modeling factors that affect the accident. Methods of data retrieval were obtained from NTSC secondary data. The data is processed by identifying factors that cause the accident. Furthermore, data processing and analysis used the PCA method to obtain mathematical modeling of factors influencing the inter-city bus accidents. The results showed that the main factors that cause accidents are health, discipline, and driver competence.

Keywords: driver, bus, safety, accident, traffic

1. Introduction

The safety of inter-city bus public transportation in Indonesia is still far from expectations. This can be seen from various accident incidents involving bus fleet in the last few years as well as data from NTSC and Indonesian Police [1] [2]. The incidents of bus accidents involving buses in Indonesia mostly include East Java, Central Java, West Java, DKI Jakarta, and other provinces. The incident is an accident with a lot of casualties. The incidents of the accident were at least more than 8 deaths, so the incident of the accident became the attention of the National Transportation Safety Committee (NTSC) to conduct an investigation.

As indicated by the party who has responsibility in the event of accident, either from the Police, Transportation Department / Ministry of Transportation, or NTSC, that the incident involving bus accidents other than caused by the factors of vehicles, roads, and environment also become the main factor Is the driver [3] [4]. The misbehaving driver behavior with high speed, as well as low traffic discipline is thought to be a major factor in road traffic accidents. In addition the health condition and stamina of the driver can also affect the concentration while driving on the highway [5] [6].

In the case of certain drivers who are still beginners or who are still a bit of experience in terms of driving the bus can also cause an accident. In general, driver performance issues are still many things that need to be addressed [7] [8]. Of course, in the improvement of public transport bus safety, more reliable identification is needed to determine the factors that caused the accident [9] [10] [11].

This research aims to determine the factors that cause accidents associated with the driver's performance as well as make mathematical modeling of factors that contribute to the cause of inter-city bus accidents. Thus, the safety of inter-city bus public transportation in Indonesia can be addressed from the driver behavior aspects found in this research.

2. Bus Accidents

Traffic Accidents are unexpected and unintentional incidents involving vehicles with or without other road users resulting in human casualties and / or property losses. While the opposite condition of the accident known as safety. Thus the notion of traffic safety is a situation where everyone is avoided from the risk of accidents during traffic caused by four main factors: human, vehicle, road, and / or



environment [12]. In public bus transportation, the human factor is more directed to the driver with various behaviors such as vehicle speed, traffic discipline, competence, health and stamina.

In general, inter-city bus public transportation has the main characteristics of vehicle operation on the highway such as long-distance and high-speed travel. Meanwhile, the driver also has different characteristics in driving. With the operational characteristics and the driver according to the research results of Taylor et al. and Yang, the driver tends to experience fatigue so that with inadequate vehicle control [6] [13].

Incidents involving bus accidents in Indonesia with varying degrees of severity and number of victims vary widely, ranging from minor accidents, serious accidents or fatal accidents. According to Police report records that accidents involving buses accounted for 4% of total accident incidents [2]. Since 2009 until 2015, the special fatal category and the center of public attention there are 25 events scattered throughout the territory of Indonesia. The fatal definition is very fatal in this case is the incidence of accidents involving public buses that resulted in the death of more than 8 people, and consequently the incident was investigated by the NTSC [1]. The incidence of fatal accidents involving bus public transport in Indonesia has been obtained data as in Table 1. While examples of bus conditions post-accident events as in Figure 1.

As shown in Table 1, the data has been detailed on the location and date of the accident, the incidence of accidents involving other vehicles, and the number of casualties. The table indicates that incidents involving bus accidents in Indonesia are very severe and require more focused attention by various parties, from the government, owners of bus companies, and the general public [1].



Figure 1. Example of Bus Condition after Accidents [1].

3. Driver Performance

The driver has a very important role in the safety of bus transportation, because the driver controls the vehicle in running the vehicle. Maneuvering of vehicles on the highway depends largely on the attitude and behavior of the driver. How the vehicle maneuver depends on the perception of the driver in maintaining traffic conditions on the highway. In addition the character of the driver's response style in maneuvering is also very influential on passenger comfort and safety [14] [15].

Much has to do with driver behavior both regarding the driver's personal condition and the behavior in the traffic interaction. A more personal aspect concerns health conditions, stamina, and competence / competence. While related to the interaction of traffic such as speed control and discipline in traffic. Of course when examined more in the above aspects can still grow again. However, according to Lin et al. Which has done the driver simulation in outline some of the aspects mentioned above is enough to describe some aspects related to driver behavior [3].

Table 1. The worst traffic accidents involving a bus in Indonesia [1].

No	Location/Date of incident	Bus accident	No. of victim (person)		
			Deaths	Serious injures	Minor injuries
1	West Jakarta /6 December 2015	Bus collision with train	19	4	0
2	Cirebon/14 July 2015	Single accident bus crashed into a pole	11	42	0
3	Subang/17 June 2014	Bus collision with car	9	12	35
4	Bekasi/8 March 2014	Bus collision with train	0	38	0
5	Bogor/21 August 2013	Bus collision with truck	20	34	0
6	Banyumas/10 August 2013	Bus VS Car and Motorcycle	15	6	6
7	Cianjur/27 February 2013	Single accident bus crashed into a cliff	17	26	38
8	Lampung/14 September 2012	Single accident bus crashed into a ravine	9	6	5
9	Sidoarjo/7 August 2012	Bus VS Car and Motorcycle	8	32	0
10	Simalungun Sumut/28 June 2012	Single accident bus crashed into a ravine	8	4	0
11	Hurau Sumut/1 May 2012	Bus fire	13	4	7
12	Bogor/2/10 February 2012	Bus collision with car motorcycle	14	10	44
13	Sumedang/1 February 2012	Single accident bus crashed into a ravine	12	26	0
14	Indramayu/17 December 2011	Bus collision with car	8	22	0
15	Mojokerto/ 12 September 2011	Bus collision with bus	20	12	0
16	Tanapuli Sel/26 June 2011	Single accident bus crashed into a ravine	19	0	0
17	Madiun/22 May 2011	bus collision with truck	10	0	3
18	Temanggung/7 February 2011	Single accident bus crashed into a ravine	11	36	0
19	Batang/16 March 2010	Bus VS Trailer	10	12	21
20	Tuban/1/1 November 2009	Bus collision with truck	8	4	2
21	Subang/2/26 September 2009	Bus collision with car	9	14	0
22	Tuban/2/24 September 2009	Bus collision with bus	7	2	1
23	Klaten/5 July 2009	Bus collision with train	7	2	1
24	Tanah Datar/31 May 2009	Single accident bus crashed into a ravine	13	12	13
25	Kediri/23 February 2009	Bus collision with train	9	19	6

4. Research Method

Research on safety-related driver behavior is based on the conceptual framework that there are many factors that affect the driver's performance. Poor driver performance may lead to a higher risk of accident risk. In this study, some driver performance variables are analyzed whether they have contributed to the effect of accidents. Driver factor variables include speed, stamina, health, discipline and driver competence. Based on previous research, many statistical analysis methods used to predict

and determine the factors of accidents such as those conducted by Zairi and Khabiri, Suraji, and Sezhian et.al. [16] [17] [18].

The accident data was obtained from the National Transportation Safety Commission (NTSC). The scope of the incident area covers the whole of Indonesia over the past 6 years from 2009 to 2015. Causes of accident from the driver's aspect are identified which includes speed, stamina, health, discipline and competence. Furthermore, the data is codified by marking if there are factors causing the accident from the event given the code number 2, whereas if not the cause of the accident coded the number 1.

After codification, the data is processed and analyzed using SPSS software with Principal Component Analysis (PCA) method. This chosen statistical analysis method is similar to that done by Sezhian et.al [18]. In the early stages of analysis is done descriptive statistical test, Further data analysis is done PCA extraction to obtain mathematical equations. This mathematical equation is the result of accident modeling caused by the performance and behavior of the driver. To complete the understanding of the results of the analysis, also made biplot 2 dimension that shows the closeness between the locations of the accident with various factors that exist in the driver's aspect.

5. Data and Analysis

5.1. Descriptive statistics of driver performance

Driver's factor consists of five variables, namely: speed, stamina, health, discipline and competence. In each variable is divided into two categories. The first category is a condition related to accident prevention and the second category is an accident trigger.

Descriptive statistical results in Table 2 explain that the indiscipline and incompetence are two variables supporting accidents that are still often encountered in the driver. Accidents happen, 88% due to undisciplined and 60% due to incompetent driver. Furthermore, in PCA for the five variables in the factor will be extraction dimension.

Table 2. Descriptive statistics of driver performance.

Variable	Categories	Frequency	Percentage (%)
SPEED	Normal Speed	12	48,0
	High speed	13	52,0
	Total	25	100,0
STAMINA	Fresh	21	84,0
	Fatigue /Sleepy	4	16,0
	Total	25	100,0
HEALTH	Healthy	22	88,0
	Unwell	3	12,0
	Total	25	100,0
DISCIPLINE	Discipline	3	12,0
	Undisciplined	22	88,0
	Total	25	100,0
COMPETENCE	Competent	10	40,0
	Less competent	15	60,0
	Total	25	100,0

5.2. Mathematics model of PCA statistics method

Statistical analysis to determine the factors causing the accident used Principal Component Analysis (PCA) method. The data structure of the cause of the accident on the driver factor in the PCA can be extracted into 5 dimensions. The summary of the analysis results is shown in Table 3.

Table 3. PCA extraction of driver performance.

Variable	Dimension				
	1	2	3	4	5
SPEED (X_{11})	-0,342	0,805	-0,359	-0,235	0,224
STAMINA (X_{12})	0,159	0,709	0,606	0,296	-0,128
HEALTH (X_{13})	-0,844	-0,165	-0,029	0,459	0,222
DISCIPLNE (X_{14})	0,899	-0,073	0,153	0,094	0,393
COMPETENCE (X_{15})	-0,502	-0,177	0,759	-0,349	0,138
Eigen Value	1,915	1,216	1,096	0,484	0,289
Total of Varian (%)	38,30	24,31	21,92	9,67	5,78
Cumulative of Varian (%)	38,30	62,61	84,54	94,21	100,00

There are three dimensions that have Eigen value of more than 1, i.e. the first to third dimension with the cumulative total variance that can be explained is 84.54%. These three dimensions are sufficient to replace the extraction of the five variables present in the driver's factor. Thus the end result will be used extraction up to the third dimension. The cumulative total variant that can be explained up to the third dimension is 84.54%. The equations resulting from the three dimensions are found in Equations (1), Equations (2), and Equations (3).

$$PC_{11} = -0,342 X_{11} + 0,805 X_{12} - 0,359 X_{13} - 0,235 X_{14} + 0,224 X_{15} \quad (1)$$

$$PC_{12} = 0,159 X_{11} + 0,709 X_{12} + 0,606 X_{13} + 0,296 X_{14} - 0,128 X_{15} \quad (2)$$

$$PC_{13} = -0,359 X_{11} + 0,606 X_{12} - 0,029 X_{13} + 0,153 X_{14} + 0,759 X_{15} \quad (3)$$

where:

PC_{13} : Principal component of driver performance

X_{11} : Variable of speed

X_{12} : Variable of stamina

X_{13} : Variable of health

X_{14} : Variable of discipline

X_{15} : Variable of competence

In the first dimension (PC_{11}) the great coefficients are in health (X_{13}), discipline (X_{14}) as well as competence (X_{15}) and the three are marked positive and negative. This first dimension explains a stronger relationship between the three variables. This dimension explains that the cause of accidents of the driver factor, 38.30% is explained by the health condition, the degree of discipline and competence. The results of this research are in line with research conducted by Taylor et al especially related to variable speed [6]. While the variable discipline of this research is similar to the research conducted by Symmons et.al [5]. From the research conducted this health variable is a newly discovered variable as the cause of the accident factor from the driver's condition.

The second dimension (PC_{12}) coefficient is large at speed (X_{11}) and stamina (X_{12}) and both coefficients are positive. This second dimension explains a stronger relationship between the two variables. This dimension explains that the cause of accidents of the driver factor, 24.31% is explained by the speed and stamina.

The third dimension (PC_{13}) coefficients are large in stamina (X_{12}) and prowess (X_{15}). The contribution of stamina has also been described in the second dimension. This dimension explains that the cause of accidents of the driver factor, 21.92% explained by stamina and competence. The results of this extraction give some conclusions that in many locations the driver's problems are strongly related to health and discipline. The results of this study also show there is no positive relationship between the conditions of the driver in good health with indiscipline.

In the second and third dimension results, the variables that are different from the first dimension are stamina, and the total variant for the two dimensions is smaller than in dimension 1. Therefore equation (1) as a sufficient result represents the modeling of accident factors from the behavioral aspect driver. Thus, the factors that cause accidents are influenced by poor health conditions, undisciplined, and incompetence of the driver. The results of this study for undisciplined behavioral variables and velocities are in line with research conducted by Symmons et.al, Taylor et al, and Suraji et al. [5] [6] [19] [20].

5.3. Biplot result of driver performance

Biplot driver factor is the visualization of the results of the analysis of all the events and the first two dimensions are generated. Biplot results as shown in Figure 2. The figure explains that more than half of accident incidents are always related to the five variables in the driver factor, namely variable speed, stamina, health, discipline, and competence.

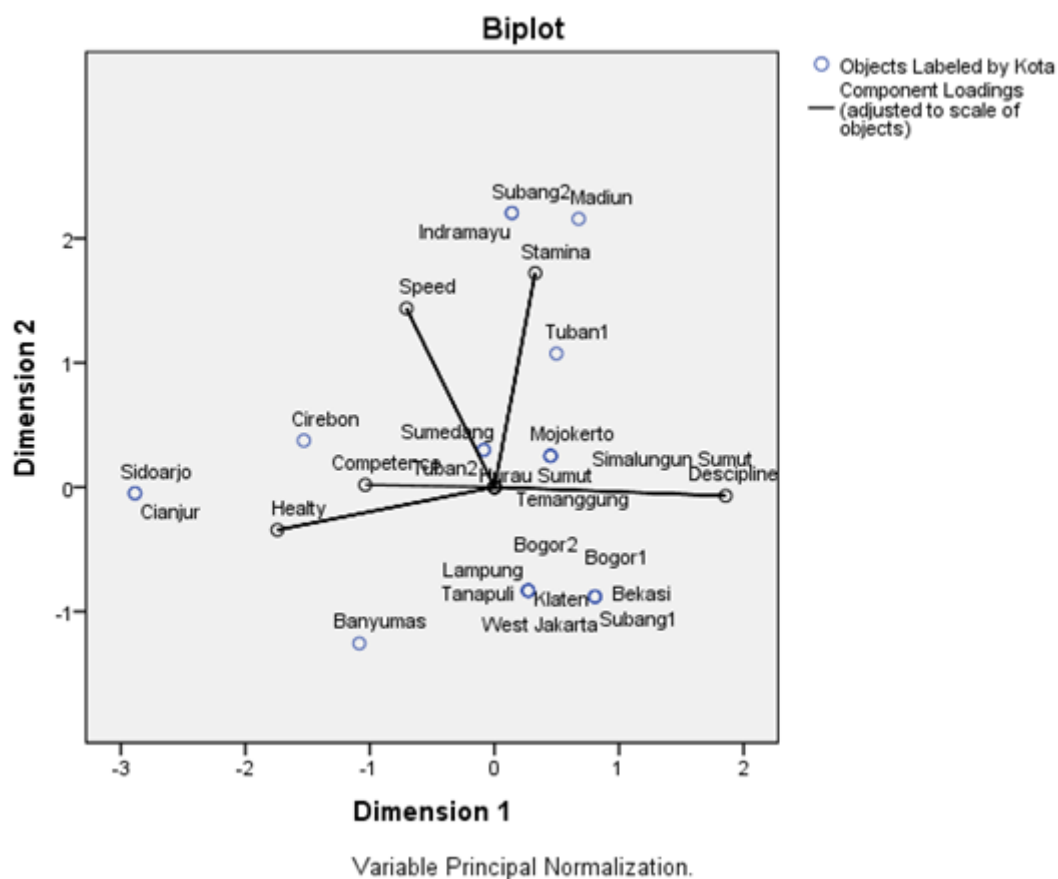


Figure 2. Biplot driver performance and accident locations

The results of research indicate that a number of accidents occur due to the condition of the driver with an unfavorable stamina so cannot control the speed. On the other side of the biplot picture also explains that the cause of accidents due to poor health conditions followed by the decline in proficiency. However, the results of this study also obtained information that the condition of drivers who are in poor health and less competent will always be careful in driving so tend to be more disciplined in bringing the vehicle. The results of this study are similar to the research done by Lin et.al, which used simulation method to know the driver behavior [3].

6. Conclusions

From the results of discussion and analysis of research can be concluded as follows: Mathematical equations modeling related to driver performance affecting bus inter-city bus accidents where accidents are affected by health condition, discipline rate, and driver's competence with equation $PC_{11} = -0,342 X_{11} + 0,805 X_{12} - 0,359 X_{13} - 0,235 X_{14} + 0,224 X_{15}$. From the extraction results in statistical analysis shows that the problem of bus drivers of inter-city buses is very closely related to the health and discipline of the driver. Furthermore, the result of biplot behavior of the driver which is the visualization of all the resulting events shows that more than half of accident incidents are always associated with all the variables available are speed, stamina, health, and competence. A number of accidents occur due to the condition of the driver with good stamina that is not good enough to control the vehicle, poor health and less competent.

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