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Reducing Accident Rate by Installing Speed Limiter Integrated Fatigue Analyzer (SLIFA)

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Abstract. Traffic accident become a serious problem in Indonesia, Indonesia police department recorded 3-4 fatalities per hour caused by traffic accidents and 10% of accidents. The second highest fatalities in the road caused by buses. It recorded by PT Pertamina persero that the major factor that caused the accidents are over speed and fatigue form the driver. The aim of this study is to reduce the accident rate by limiting the maximum speed of the vehicle due to government regulation and the occurrence of fatigue from driver. Speed limiter integrated fatigue analyzer installed to the trucks and buses. The top speed of vehicle is locked at 70 km/h. when the driver want to speed up, fuel cut off solenoid will reduce fuel supply to the engine and it will reduce engine speed/rpm. By installing SLIFA average top speed can be reduced up to 83% and accident rate can de reduced up to 50%.

INTRODUCTION

Nowadays, traffic accidents are concerned as a serious problem. Approximately 1.3 million people killed caused by road accident [1-2]. In 2013, the number of fatalities caused by road accident in Indonesia increased from 32,301 to 85,596 cases. Since 2011-2013, the most of transport accidents happened to bus and police department recorded approximately 9.278 cases of bus accident by that time. In 2015, Jakarta police department recorded 6,231 cases of road accident which caused 556 people killed. There are several factors that cause traffic accident, such as external (34%), attitude (24%), fatigue (20%), over speed (17%) and technical vehicle (5%). Fatigue and over speed contribute 37% in total as a factor of traffic accident in Indonesia [3-4].

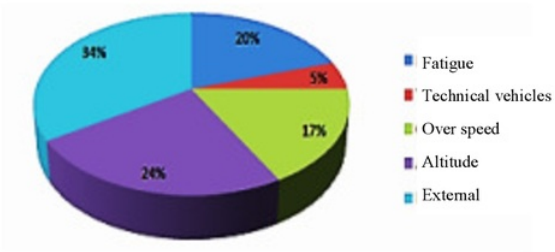

FIGURE 1. Factors of traffic accidents in Indonesia.

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In order to improve the traffic safety of the community, safety driving as based principal of transportation should be implemented [5]. The Indonesian government regulation set the speed limit provision on highway is 70 km/h while on urban arterial roads is 40 to 50 km/h and the maximum speed on pedestrians is only is 30 km/h. the aim of regulation is to decrease the accident rate. But, many drivers disobey the regulation [6-8]. Speed is concerned as a key factor for understanding traffic accident rates and accident severity. By decreasing in speed by 1 mph it can reduces the accident rate by 3.7 (motorways)–5.7% (rural roads) [9-11]. Therefore, installing the additional part in the engine to limit the speed is quite needed, which may reduce the accident rate. In this research initiate to develop new speed limiter which coupled by fuel cut-off solenoid to limit the speed by reducing supply fuel into the engine [12-14].

METHODOLOGY

Speed limiter is installed in trucks and buses of PT. Pertamina and PT. Pahala Transport. The basic principle of speed limiter is give a sign when the bus in over speed. When the vehicle over speed it will automatically cut off the fuel that will reduce vehicle speed. Schematic diagram of speed limiter fatigue analyzer is shown in Figure 2.

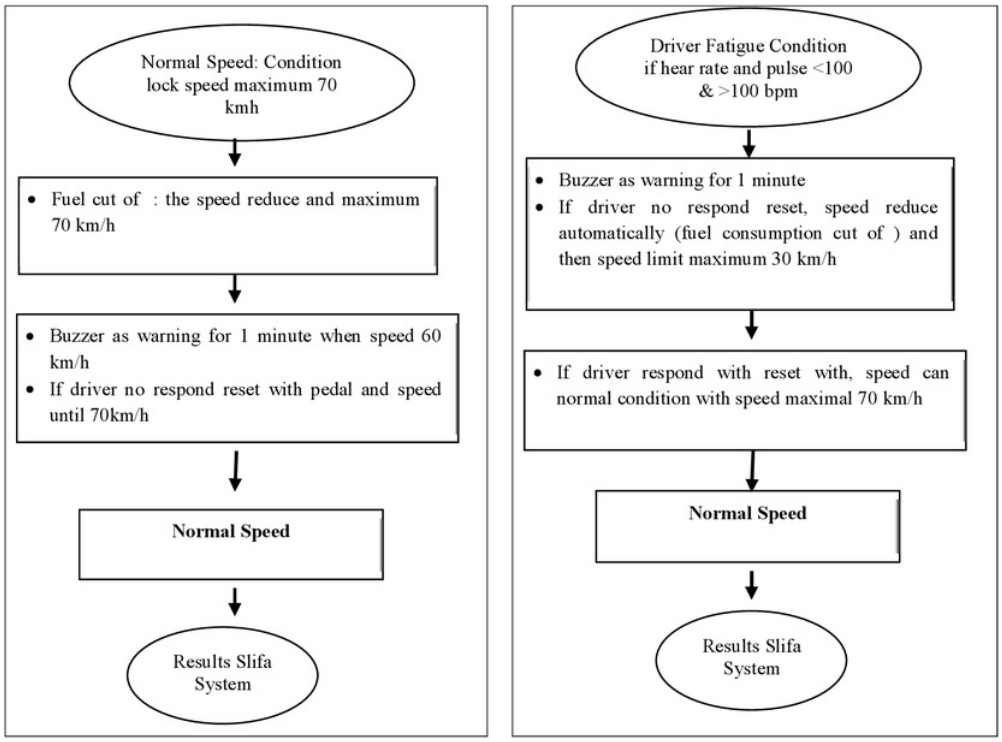

FIGURE 2. Schematic Diagram of Speed Limiter and Fatigue Analyzer.

The modification of the speed limiter installation has been done by improving on electrical wire which placed and connected with the machine. It controlled and developed based on government regulation depending on the urban or highway speed. The speed limiter installation procedure is shown in Figure 3 and Figure 4 where it consists of buzzer, ECU, speed sensor, engine and speed limiter control box.

When the vehicle speed exceeds a specified speed limit speed sensor on the transmission output will send frequency signal to accelerator pedal, then the frequency signal is transformed into a voltage signal at IC program.

The voltage signal is transformed into the comparators components, forwarded to relay and followed by sound a warning alarm buzzer. When the driver still performs additions speed, fuel shut off solenoid will reduce the fuel consumption into the engine and it will reduce the speed/rpm to the normal speed. Meanwhile, when the driver is slow down the speed, the buzzer alarm will be stop and back to the normal speed.

The driver fatigue sensor paired in dashboard detect heartbeat of the driver. If fatigue detected (heart rate <100 and pulse >100 bpm) buzzer will give warning for 1 minutes. The driver should set the buzzer. Or, automatically the vehicle speed will reduce to 30km/h and it will be back to normal only when the driver reset it.

Effectiveness of SLIFA in speed limiting

The monitoring activity has been conducted for 1 month on selected bus and truck before installed speed limiter. The data is summarized in table 1 that the highest speed is shown by truck id B 9511 UFU for 133 km/h and the lowest speed shown truck id B 9211 SHE for 122 km/h and bus id HT 691 highest speed 136 km/h, lowest bus id HT 002 for 120 km/h. That speed is out of regulation which mean that the attitude of the driver is not appropriate with safety driving guideline and government regulation.

TABLE 1. Speed Effectiveness of Limiting Speed.

ENGINE TYPE	VEHICLE ID	BEFORE INSTALLED SLIFA		AFTER INSTALLED SLIFA	
		TOP SPEED	AVERAGE SPEED	TOP SPEED	AVERAGE SPEED
TRUCK SG 500	B 9280 UU	125	88.4	60	50.3
	B 9281 UU	130	87.6	70	60.2
	B 9263 UU	130	88.8	70	67.2
	B 9264 UU	128	90.4	69	55.3
	B 9511 UFU	122	89.5	66	52.6
	B 9211 SHE	133	92.3	70	65.8
BUS 1526	HT 002	120	86.3	70	68.3
	HT 006	122	87.4	70	69.3
	HT 634	121	85.4	70	63.6
	HT 674	124	86.6	69	68.5
	HT 691	136	88.1	64	67.3

Testing is done to the truck and bus engine.From the result shows that top speed which performed by driver up to 133 km/h when truck uninstalled by speed limiter. Meanwhile, when speed limiter is installed to the truck, top speed locked at 70 km/h even though the driver want to speed up. It means that fuel cut-off system is very effective to lock the speed at 70 km/h and it shown the improvement up to 65%. For the bus, after the installation speed limiter the highest and average speed of 136 km/h and 123.5 km/h is observed by bus speed prior to use speed limiter. After speed limiter applied in the bus, the approved maximum speed is 70 km/h. Those data approve that the speed limiter can reduce 83% from the top speed before speed limiter applied.

Report Accident after Installation SLIFA on the Truck and Bus

Data shows the number of potential incident which recorded by July 2016 – January 2017 two company in Indonesia PT.Pertamina Persero and PT.Pahala Transports. There are several decreasing incident cases observed before and after installing SLIFA.

1. Shift of incident report period July 2016-Feb'2017

Based on the observation that has been done to see the decline of accident potential from July 2016 to January 2017, it shows the significant decrease in the category of shift incident as shown in Table 2.

TABLE 2. Shift of Incident period July 2016-January 2017.

	Periode Jan – Jun 2016	**UOM**	**Period Jan – Jun 2016**	**UOM**
Morning	20%	10	13%	5
Afternoon	33%	17	59%	23
Night	25%	13	23%	9
Daylight	22%	11	5%	2
Total Cases	**100%**	**51**	**100%**	**27**

2. Location of incident report period July 2016-Feb' 2017

Based on the observation that has been done to see the decline of accident potential from July 2016 to January 2017, it shows the significant decrease in the category of location incident as shown in table 3.

TABLE 3. Location of Incident period July 2016-January 2017.

	Period Jan – Jun 2016	**UOM**	**Period Jan – Jun 2016**	**UOM**
Highway/type 1	10%	5	11%	3
Toll	45%	23	56%	15
Pedestrian Road	18%	9	7%	2
Highway/type 2	4%	2	4%	1
Others	24%	12	22%	6
Total Cases	**100%**	**51**	**100%**	**27**

3. Classification of incident and type of incident report July 2016-Feb' 2017

Based on the observation that has been done to see the decline of accident potential from July 2016 to January 2017, it shows the significant decrease in the category of shift incident as shown in table 4 and Figure 8.

TABLE 4 Classification of Incident report period July 2016-Feb 2017.

	Period Jan – Jun 2016	**UOM**	**Period Jan – Jun 2016**	**UOM**
Over speed	16%	8	13%	3
Fatigue	76%	39	83%	20
Premature Loss	8%	4	4%	1
environmental	0%	0	0%	0
Total Cases	**100%**	**51**	**100%**	**27**

CONCLUSION

The speed limiter integrated fatigue analyzer control systems were successfully installed and tested. The system had succeeded in limiting the engine speed by set the maximum speed value according the government regulation and fatigue detected according to driver heart rate. It can be an effective way for public transportation company for protecting their trucks and buses, their driver, and also their environment. By limiting the vehicle speed according to the regulation, it avoided the driver to over speed while driving. Thus, the accident rate decreased. By installing the SLIFA, vehicle top speed is locked at 70km/h and the accident rate can be decreased almost 50% cases.

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