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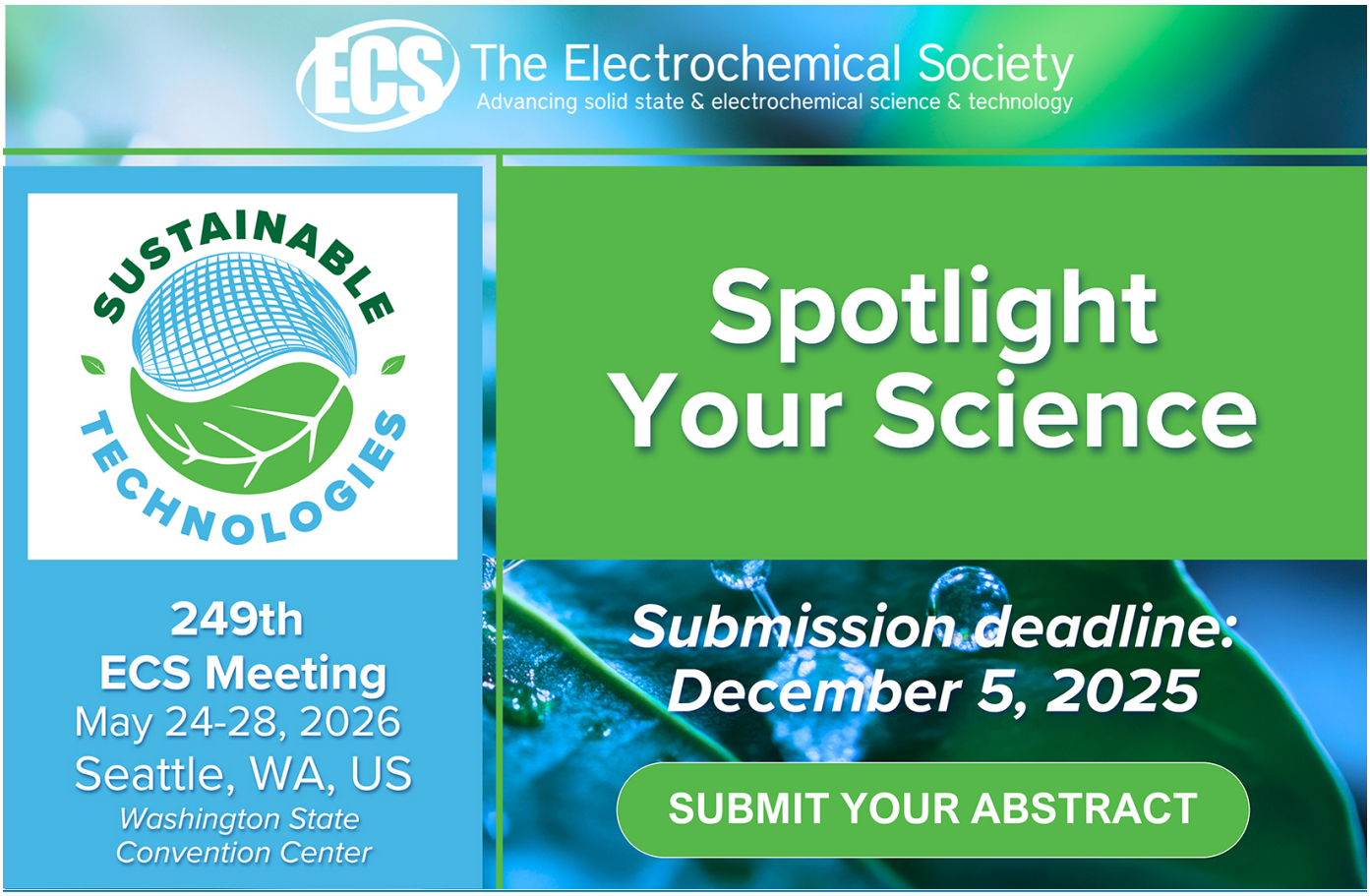

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Impact on Driver Behavior, Performance, Fatigue, Over Speed and Infrastructure as A Factor of Road Accident: A Review

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Abstract. Road safety is become an interesting field to be investigated due to high road accident that still occurred in the world and it increased every year. Second highest accident rate in the world signed by South-east Asia with 20.7 per 100.000 population. That rate include the road accident that occurred in Indonesia. There are several parameters in road accident such as infrastructure, driver behaviour, environment, driver performance, driver fatigue, over speed, vehicle and safety device. Therefore, this study approach a model to interconnect the variables in order to achieve a pattern of road accident factors. This study believe will be improve the awareness of the related agency to increase their responsibility in improving and applying road safety. Moreover, this study output will be comprehensive discuss and critical discussion in terms of road safety plan that may applied in order to reduce the road accident.

1. Introduction

Road safety is become an interesting field to be investigated due to high road accident that still occurred in the world and it increased every year. Second highest accident rate in the world signed by South-east Asia with 20.7 per 100.000 population. That rate include the road accident that occurred in Indonesia. There are several parameters in road accident such as infrastructure, driver behaviour, environment, driver performance, driver fatigue, over speed, vehicle and safety device. Therefore, this study approach a model to interconnect the variables in order to achieve a pattern of road accident factors. This study believe will be improve the awareness of the related agency to increase their responsibility in improving and applying road safety. Moreover, this study output will be comprehensive discuss and critical discussion in terms of road safety plan that may applied in order to reduce road accident. Figure 1 show the population, road traffics deaths, and registered motor vehicle by the country**.**

The accident rate in South-East Asia that dominated by developing country like Indonesia that show the road accident that consists of pedestrian, motorcyclist, passenger car, bus and truck. In 2019 there were 107.500 cases, which increased 3% as compared to road accident in 2018. However, the road traffic

death in 2019 was decreased for 6% as compared to road traffic death in 2018 for 23.530 road fatalities. The road fatalities majority caused by three main factors which are human factor for 61%, environment and infrastructure factor for 30% as well as vehicle factor for 9% [2].

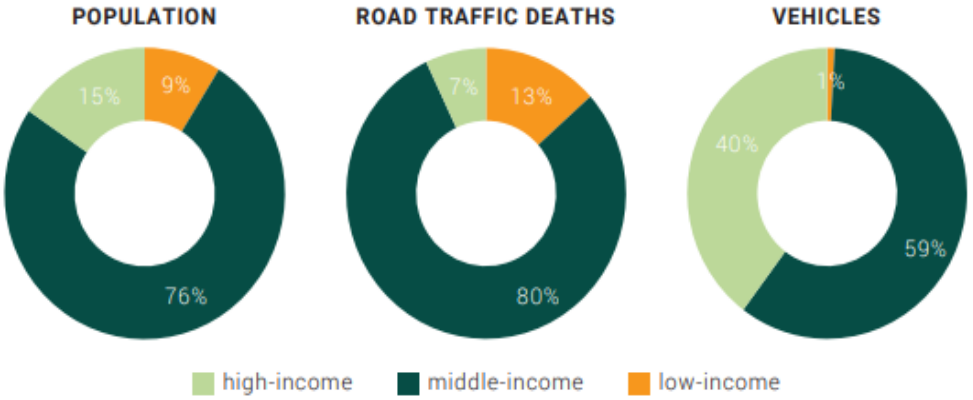

Figure 1. Proportion of population, road traffic deaths, and registered motor vehicles by country 2016 [1]

There are several factors that influence on road accident such as driver behaviour, driver performance, driver fatigue, infrastructure, environment and over speed. Figure 2 show the Rates of road traffic death per 100,000 population by WHO regions: 2013, 2016 [1].

Figure 2. Rates of road traffic death per 100,000 population by WHO regions: 2013, 2016 [1].

2. Review on Factor of Road Acciden.t

2.1. Driver Behaviour

Driving behaviour was consists of errors and violations as shown in table 1. Errors means that the driver unable to achieve their intended consequences that divided into three major categories which are slips, mistakes and lapses. Meanwhile violation is more complex than errors due to involved the operating procedure, codes, norm and rules [3]. Driver behaviour can be a significant factor to control the road accident [4]. The driver behaviour was influenced by several factors such as vehicle, environment factor, demographic characteristic and roadway-related features [5]. In case of truck and bus driver manly caused by driver distraction that included on the driver task that action the activity exclude a driving task such as interaction with passenger, non-driving related device such as ticket machine, radio headset and radio [6], location, traffic sign, driver age, gender, and experience [7, 8].

Table 1. Influenced factor of driver behaviour on traffic accident.

Driver behaviour	Influenced Factor	Reference
Errors	Vehicle, slips, mistakes, lapses, location, traffic sign, driver age, gender, experience, environment factor, demographic characteristic and roadway-related features	[3, 5, 7, 8]
Violation	Operating procedure, codes, norm, rules, interaction with passenger and non-driving related device	[3, 6]

2.2. Driving performance

Driving performance was influenced by several factors such as ages [9], road side images such as roadside advertisement [10], weather condition such as such as fog, rain, snow, ground blizzards, slush, and strong winds [11] and driver fatigue that caused by driving distance, temperature, an ergonomic seat etc [12]. Regarding to age factor, the previous study shows that crash rates were highest for drivers between the age of 16-17, decreased until ages 60-69 but increased after age of 70 [13]. According to [14] that drivers 65 years and older were slowest to change lanes in a lane changing task, followed by first year drivers under 25 years.

There are several indicator of good driving performances which are speed consistency, maximum deceleration and low lane deviation [15]. That performance will be achieved by eliminating driver distraction from external parameters such as reaction time on other vehicle or roadside sign, acceleration, driver focus, steering reversal rate (SRR), headway, standard deviation of lane positioning (SDLP) and situation awareness [16]. That parameters will be effect on the driver by different visual and cognitive distraction. Driving distraction also effected by age and driving experience. According to [17] younger drivers are found to be more inclined (than older drivers) to engage in phone tasks during driving, their performance is found to be less affected by the phone use.

2.3. Driver fatigue and over speed related road accident

Road accident mainly caused by driver fatigue and over speed based on [18] mention that Driver fatigue and over speed contribute to the 32% and 15% of road accident, respectively. In order to reduce the number of crashes caused by fatigued driving, active safety systems that monitor driver states have been developed to provide driver alerts and/or control intervention [19]. The existing fatigue monitoring system was provided the alarm when the driver close to fatigue condition in real time and that condition not adequate in the system. Fatigue will be effected on driving performance and low reaction time of driver. drivers often perform non-driving related tasks or even doze off when they over-rely on automation that effect to the takeover performance due to delayed takeover reaction time [20]. Therefore, it is very important to develop a system that can detect the driver condition in real time either fatigue, close fatigue or not.

In addition, driver fatigue and over speed may influenced by various factors such as travel time, driver achievement, weather condition, driving behaviour or driving attitude and physiological factor. In previous study that conducted by [21] that they develop fatigue detector by several parameters such as mouth aspect ratio, temperature, heart rate, eye aspect ratio and integrated with speed limiter with fuel cut off system. The speed limit has been regulated by The Ministry of Transportation in Indonesia in order to reduce the number of traffic accidents. Therefore, the ministry has issued the regulation of speed limit for commercial buses based on area which consists of maximum speed of 100 km/h in highway, 80 km/h in urban area, 50 km/h in centre of urban area, and 30 km/h in the residential area [22].

2.4. Infrastructure effected to road accident

One of the most critical factors that effecting to the road accident is rad infrastructure and environment such as geometrical design, lighting, road type, road quality, weather conditions and traffic control [23]. The 10 infrastructure elements that are included are as Exposure (e.g. traffic flow, traffic composition), Road surface, Road environment (e.g. weather, lighting), Road type, Alignment – road segments, Traffic control - road segments, Presence of work zones, Cross-section - road segments, Traffic control – junctions and Alignment – junctions.

Environment refers to human-road interaction such as road infrastructure, traffic sign, traffic light and any circumstance that affected the driving condition, described in the percentage of accident occurences consisting of acident type same direction, pedestarian, fixed object, direction and hit animal and than risk factor consist of three things that are veri important in reducing the potentional for accident on the road human, environment, vehicle, some factors are considered very important to be agreed in every ride made by a driver. Contribution of environment factor to the road traffic accident is listed in table 2.

Table 2. Contribution of environment factor to the road traffic accident [24]

Accident type	Risk factor			Statistically significant relationships
	Human	Environment	Vehicle	
Sideswipe: same direction	75	20	5	Negligence, dangerous overtaking, sight distance, faulty indicators, cars
Pedestrian	75	25	0	Driving on the shoulder of the road, pedestrian visibility, speed, alcohol, pedestrian facilities, cars
Fixed object	80	15	5	Negligence, losing control, speed, alcohol, fatigue, road signs, steering, brakes, cars
Sideswipe: opposite direction	90	10	0	Dangerous overtaking, speed, males, sight distance
Hit animal	10	90	0	Speed, fencing, lighting

Today, roads are undoubtedly safer than a few decades ago, and road transport performance has improved considerably. Majority of the fatalities occur in accidents outside built-up areas, whereas motorways appear to be the safest [25]. Major highways, including motorways and freeways, are designed for safer high-speed operation and generally have lower levels of injury per vehicle km than other roads, highways that require high security to the user, so some signs and some lighting to provide the effect of driving safety at night becomes very important. Motorways are the safest road environment for fast-moving traffic and, except for measures to ease congestion such as ramp metering and variable speed limits, they are not usually subject to additional infrastructure measures for speed management purposes [26].

By contrast, in most industrialised countries, rural roads carry the greatest risk of fatalities and injury. Drivers running off the road and colliding with roadside objects in single-vehicle accidents are a major problem in the rural network in many countries, infra structure of the highway becomes the main polemic in the level of risk of accidents on the highway, this is in the presence of some things that is not understand the driver on the road being passed, thus increasing the speed can not be used in anticipation faster and also because it causes other. It is expensive and impractical to apply infrastructure-based speed management measures to the entire network to prevent these accidents [27]. However, local improvements to rural roads can be made by removing roadside obstacles such as trees, utility and sign poles, to make the road safer and more forgiving in the most dangerous locations. A highly effective solution for rural roads – which requires long-term planning would be to separate traffic travelling in opposite directions, using for example, median barriers. Some countries, such as Sweden, are progressively improving their highest risk rural roads to this standard. However, it is evident that for most countries, resource constraints prevent this measure being carried out on a large scale [28].

3. Road Safety Model and Approached Model

Road safety model were developed in order to simulate the road safety application with closed-real time condition in order to reduce the road accident when the system is applied. There are various technique to develop a model such as by mathematical model [29] such as Generalised Linear Model (GLM) using a Poisson or a Negative Binomial Distribution [30], multilevel modelling, macroscopic model for speed limit by using system dynamics of METANET model that expresses the conservation of vehicles while the second equation expresses the mean speed as a sum of the previous mean speed, a relaxation term, a convection term, and an anticipation term [31]. According to [8] given the number of components and causal mechanisms theoretically described in the TCI model, a systematic classification scheme (SCS) was developed to guide and assist in synthesising the available literature as shown in figure 3.

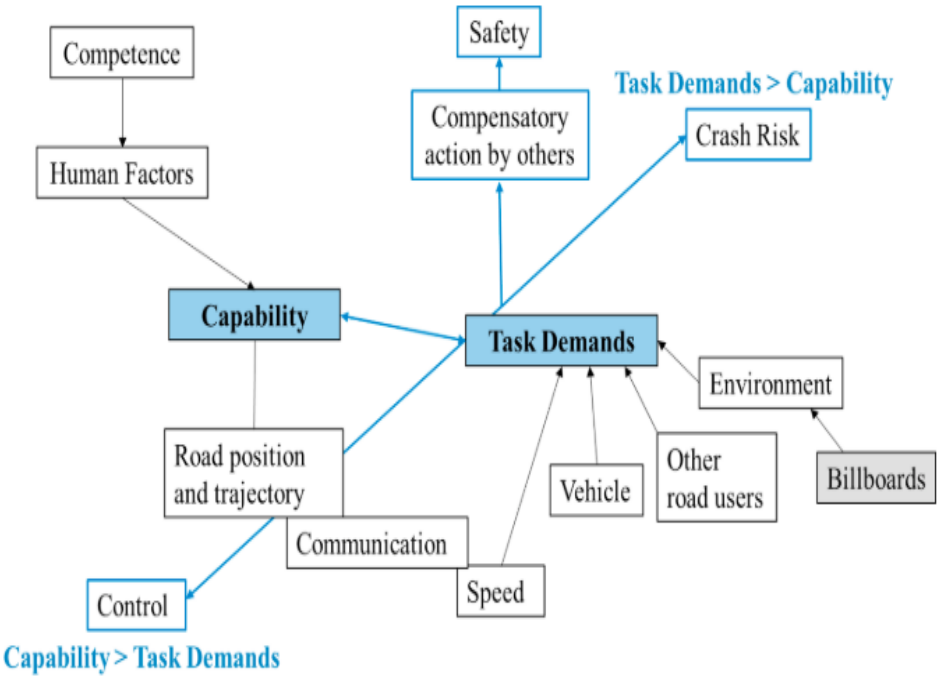

Figure 3. Task capability interface model [8]

The system approach will be correlate with several variables of road safety in terms of vehicle, infrastructure, driver behaviour, driver performance and safety device that installed in the vehicle. This approach model as in figure 4 was developed to investigate the effect of that variable on road accident. This model will be investigated by the survey and questionnaire analysis that involve the transportation company and it will levelled by likert scale. This model believe will be achieved a better knowledge in terms of road accident factor and relation between variables that contribute to the road accident that occurred every time. This model achievement will be recommend to related agency to apply this result in order to reduce the road accident and road fatalities.

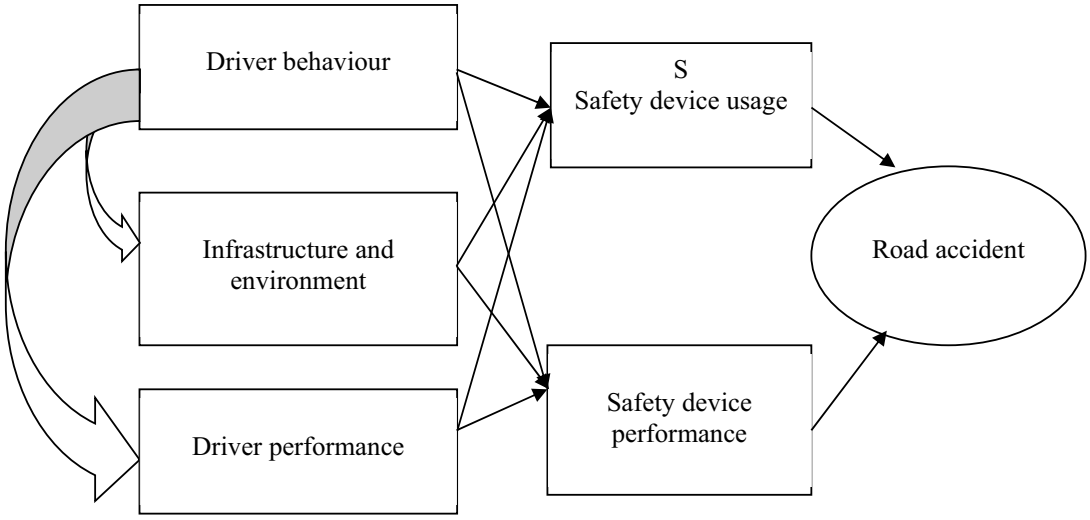

Figure 4. Approached road accident model

4. Conclusion

Road accident was influenced by several factors such as driver behaviour, driver performance, infrastructure, environment, driver fatigue, over speed, vehicle and safety device. However, the connection of each factors is become an interesting area to be investigated and it cannot separate each other. This study with approach model will be obtained the critical factor that influence to the road accident in order to take an action to solve or minimize the issues.

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