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Correlation Analysis on Crash Factor in Surabaya-Manyar Toll Road

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Abstract. Crash investigators can create crash-solving and preventive goals by knowing crash's elements, such as the number, type, factor, and element. Human factors, vehicle, road conditions, and environment are the four types of elements that influence the risk of a crash. Surabaya-Manyar Toll Road has been the main link between Surabaya and Jakarta since 1993. There were 149 crashes between 2014 and 2018, with seven fatalities. An investigation and prevention strategy might be devised to improve safety on the road. This study analyzed and discussed the correlation between crash number and volume, factor, time occurred, and road length analysis. Data on the volume of vehicles and frequency of accidents on the Surabaya-Manyar Toll Road between 2014 and 2018 were gathered through a collaborative effort between the Highway Patrol division of the East Java Regional Police and PT. Margabumi Matraraya, the toll road's management company. The result showed that the vehicle factor, human factor, time 06.00-18.00, and daily average were all significantly correlated to the crash number (0.933, 0.505, 0.984, and 0.078), while the road factor, environment factor, and time 19.00-05.00 were not significantly correlated to the crash number (-0.539, 0.616, and -0.519). These implications prompted the following analysis of preventive and action in order to determine the primary factor influencing the number of crashes, which has a strong association to be investigated.

INTRODUCTION

Indonesia's population has been continuously increasing in recent years, with a population of 255 million people in 2015. (BPS, 2015). The number of vehicles in Indonesia has increased in tandem with the country's growing population (BPS, 2016). According to prior research by Ackaah and Salifu (2011), when the number of vehicles increases, the number of crashes will increase. Indonesia's transportation system has a severe flaw, which is a traffic jam. According to the World Health Organization (WHO), road incidents in Indonesia resulted in 1.2 million deaths and 50 million injuries in 2014. (WHO, 2015). As a mode of transportation, the toll road carries the risk of a collision. A toll road or high way was created to service long-distance and high-speed travels in order to build a freeway network that would allow road users to travel faster to their destinations. Even though these goals result in a reduced journey time due to high-speed driving, they have a negative impact. In Indonesia, fatal crashes on toll roads account for 56 percent of all crashes [1]. According to information compiled by toll road organizations, road traffic accidents represent a major source of mortality and injury, with 1,075 accidents occurring on toll roads in 2017, and 1,135 accidents taking place in 2018 [2]. The East Java Regional Police conducted an inquiry into a subset of accidents in the region, which totaled 211, and caused 42 deaths, 30 serious injuries, and 248 minor injuries, as well as Rp. 356,510,000 in material damages [3].

The Surabaya-Manyar Toll Road is a thoroughfare that traverses the region of East Java, connecting the cities of Surabaya and Gresik. The toll road links up with the Surabaya-Gempol toll road, which is owned and run by PT Margabumi Matraraya, on the east side, and with the Tuban-Gresik toll road, also owned and managed by PT, which is nearing completion. This toll road features eight entry points leading from Surabaya to Manyar and five entry points from Manyar to Surabaya. Since 1993, the toll road has facilitated travel between Surabaya and Jakarta via the Pantai Utara route. As is well known, Surabaya-Manyar is an industrial district where traffic is congested due to loading vehicles and employee traffic jams. As is well known, Surabaya-Manyar is an industrial district where traffic is congested due to loading vehicles and employee traffic jams. Increased transportation capacity is further aided by harbor traffic in north Surabaya [4].

Traffic crashes are an issue that cannot be avoided, especially on toll roads. The investigator can create crash-solving and preventive goals by knowing the crash's elements, such as the number, type, factor, and element. Human factors, vehicle, road conditions, and environment are the four types of elements that influence the risk of a crash. A basic example of a human component is human neglect, such as tiredness or alcoholism. When the vehicle's safety regulations were not followed, the condition of the cars also contributed to the crash. Furthermore, road conditions such as slopes, bumps, or holes, as well as environmental variables such as wetness, must be considered. Furthermore, road conditions such as slopes, bumps, or holes, as well as environmental factors such as weather, wind, and lighting, all played a role in crash causes [5]. Humans and automobiles are the leading causes of collisions, according to them. However, there has been no conclusive statistical data on the primary reason of the collapse till now. All of those elements are unquestionably linked, but the most important one is still being investigated [6].

According to data from PT. Margabumi Matraraya, there were 149 crashes between 2014 and 2018, with seven fatalities, 31 serious injuries, and 62 minor injuries. Humans and automobiles are the leading causes of collisions, according to them. However, until today, there has been no conclusive statistical evidence as to what the primary cause of the disaster was [6]. In order to determine the significance factor impacting crash number, this study will analyze and discuss the correlation between crash number and volume, factor, time occurred, and road length analysis. After determining the correlations, an investigation and prevention strategy might be devised.

METHODOLOGY

Data pertaining to the number of road users and crash occurrences on the Surabaya-Manyar Toll Road during the 2014-2018 period were gathered through a collaborative venture between the East Java Regional Police's Highway Patrol and the toll road's operator, PT. Margabumi Matraraya. Furthermore, primary data was analyzed using SPSS to identify the key factors contributing to crash incidents on the Surabaya toll road.

RESULTS AND DISCUSSIONS

The daily traffic average volume on the Surabaya-Manyar Toll Road from 2014 to 2018 is shown below to show volume rise from year to year. Table 1 shows that the annual average daily traffic climbed from 2014 to 2017 and then declined from 2017 to 2018. Even though there was a decline in 2018, the average daily traffic volume was still greater than the average from 2014 to 2018, with 29.120.636,8 vehicles per day. This average daily traffic volume is classified as a high volume of daily traffic with a high risk of causing a road accident. Furthermore, the road between Manyar and Surabaya is classified as a toll road with a high-speed limit. The daily traffic volume grows at various times of the day, the pace of driving slows, and the entire route becomes clogged. In addition, the number of encounters between road users grows. In general, daily traffic numbers and congestion have the greatest impact on road safety [7].

Due to the occurrence effect, the number of traffic crashes was associated after knowing the daily traffic. Table 1 also revealed that the number of crashes climbed from 2014 to 2016 (from 21 to 32 and 42 incidents), then fell in 2017 (25 incidents), before increasing again in 2018 (29 incidents). Between 2014 and 2017, there was a progressive growth in the number of traffic accidents, as indicated by the mean daily traffic volume. While one aspect of road safety - the rarity of crashes - has improved, Retallack and Ostendorf's research found that the incidence of crashes was highest when traffic volumes were below 400 vehicles per hour, and lowest when volumes were between 1000 and 1500 vehicles per hour. As the number of vehicles on the road has surpassed 1500 per hour [2], the rate of accidents has similarly increased. The toll road connecting Surabaya and Manyar registered the highest daily traffic volume in 2017, with an average of 29.120.636,8 vehicles utilizing it per day.

TABLE 1. The average daily traffic volume and number of crashes on the Surabaya-Manyar toll road (2014-2018)

Year	Daily average (Vehicles/day)	Crash number (Cases/year)	% of crash number
2014	27.949.123	21	14
2015	28.396.040	32	23
2016	29.154.945	42	28
2017	30.195.162	25	16
2018	29.907.914	29	19
	$\bar{x}=29.120.636,8$	$\Sigma=149$	$\Sigma=100$

TABLE 2. Traffic crash factor and occurred time in Surabaya – Manyar toll road (2014-2018)

Year		2014	2015	2016	2017	2018	$\Sigma=$
Factor	Human Vehicle Road Environment	13	20	23	22	27	105
		2	10	19	3	2	36
		4	2	0	0	0	6
		2	0	0	0	0	2
	$\Sigma=$	21	32	42	25	29	149
Occurred time	06.00 – 18.00	8	21	30	9	16	84
	19.00 – 05.00	13	11	12	16	13	65
	$\Sigma=$	21	32	42	25	29	149

TABLE 3. Pearson correlation on crash number to daily average vehicle; factor; and occurred time of crashes

Pearson Correlation	Daily average vehicle	Factor				Occurred time	
		Human	Vehicle	Road	Environment	06.00-18.00	19.00-05.00
Crash Number	0.078	0.505	0.933	-0.539	-0.616	0.984	-0.519

Crash factors have emerged as the key source of worry when it comes to minimizing the number of road fatalities. Human, vehicle, road, and environmental elements are all considered. Table 2 shows that the biggest number of factors found on the Surabaya-Manyar toll road (2014-2018) was human (105 cases), followed by vehicle (36 cases), and environmental factors (none). Human-related errors have been recognized as the main factor in road traffic crashes since the quality of roads, cars, and environmental elements has been manipulated and prevented [8]. Despite the fact that various restrictions relating to safe driving have been put in place, individuals have a habit of disobeying them.

Some of the crashes also pointed to certain time periods. According to PT. Margabumi Matrajaya (Table 2), 84 occurrences of collisions occurred on sunny days between 06.00 and 18.00 am between 2014 and 2018. There were 65 incidents between 19:00 and 5:00 p.m. As is well known, between the hours of 06.00 and 18.00, all types of cars were on the road on their way to work for the office, producing traffic congestion and crashes [9]. At night, however, only heavy-loading trucks, which typically have a low-speed limit, were present. The number of crashes at night, though, was likewise high. Following certain collisions, drivers overwhelmingly rejected the installation of overhead illumination [3].

After all of the variable data had been collected, a Pearson correlation analysis could be performed. Table 3 shows that the vehicle factor, human factor, time 06.00-18.00, and daily average were all significantly correlated to the crash number (0.933, 0.505, 0.984, and 0.078), while the road factor, environment factor, and time 19.00-05.00 were not significantly correlated to the crash number (-0.539, 0.616, and -0.519). These implications prompted the following analysis of preventive and action in order to determine the primary factor influencing the number of crashes, which has a strong association to be investigated.

CONCLUSION

The vehicle factor, human factor, time 06.00-18.00, and daily average were all significantly correlated to the crash number (0.933, 0.505, 0.984, and 0.078), while the road factor, environment factor, and time 19.00-05.00 were not significantly correlated to the crash number (-0.539, 0.616, and -0.519).

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