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Operational Data Analytics of Over Dimensional and Overloaded Truck in Indonesia

Anton Budiharjo[1], Tina Andika[1], Nurul Fitriani[1], Rukman[1], Buang Turasno[1]
[1]Rekayasa Sistem Transportasi Jalan, Politeknik Keselamatan Transportasi Jalan, Tegal, Indonesia

Abstract

Over Dimension and Overload (ODOL) vehicles are one of the factors that cause road conditions to be easily damaged and potholes and can cause the risk of traffic accidents. ODOL vehicles are considered very detrimental to road infrastructure and increase the risk of accidents, inefficiency due to damaged road conditions, and air pollution because of excess exhaust gases. Road damage due to ODOL also triggered an increase in the budget for the maintenance of national roads, toll roads, and provincial roads, with an average of Rp 43.45 T per year. Based on data from the National Police Corps from the Integrated Road Safety Management System (IRSMS) regarding accidents in 2018, ODOL trucks are one of the biggest contributors to traffic accidents. This study aims to determine the causes of vehicle overload and over dimension. The method used is to use the triangulation method. Triangulation of techniques means that researchers use different data collection techniques to obtain data from the same source. The results showed a relationship between vehicle modification and ODOL violations which were proven using Chi-square analysis. The chi-square value is 55,259 with a p-value of 0.000 at a significance level of 1 % (P-value < α=1). This shows a significant relationship between vehicle modification and Over Dimension and Overload (ODOL) vehicle violations.

Keywords: *Infrastructure damage, traffic accidents, ODOL, Road Safety*

INTRODUCTION

One of the factors that cause road damage and can pose a risk of traffic accidents is caused by vehicles with more load capacity, known as Over Dimension and Overload (ODOL) (Budiharjo et al., 2021). Indonesia's ODOL violations on freight transportation have become a serious problem (Kinasih, 2020). ODOL vehicles are considered very detrimental to toll road operators and increase the risk of accidents, inefficiency due to damaged road conditions, and increased air pollution due to excess exhaust gases caused (Krebs & Ehmke, 2021). Based on data from the Directorate Jenderal of Land Transportation on seven weighbridges in Indonesia in 2018, as many as 75 percent showed vehicles that committed overloading violations, even 25 percent related to violations whose load exceeded 100 percent. According to data from National Police, there has been an increase in traffic accident cases caused by ODOL transportation from 2020 to 2021, which is 0.03%, and fatalities have increased by 0.06%. In addition, the impact of ODOL vehicle congestion, damage to roads and bridges, and air pollution (Anwar et al., 2020). The problem of freight transportation, especially ODOL vehicles in Indonesia, is very complex and stretches from upstream to downstream (Simanjuntak, 2014).

The impact of ODOL vehicles, in addition to causing road damage (Ryguła et al., 2020), also causes damage to other infrastructure such as bridges, ship damage in cases of crossings and causes traffic accidents (Ghisolfi et al., 2019; Alkhoori & Maghelal, 2021). Accident cases involving ODOL vehicles have also occurred a lot. Even among them, it has resulted in many casualties and material

Corresponding author
Anton Budiharjo, anton@pktj.ac.id
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losses that are not small. The control of Over Dimension Overload (ODOL) vehicles is also a severe concern for the Government. The Director General of Land Transportation of the Ministry of Transportation has stated that by 2023 Indonesia will be free from ODOL vehicles. The Government has carried out the cross-agency synergy between the Dishub, the Police, and toll road operators. However, after evaluation, there are still some problems related to the implementation of this zero ODOL policy; namely, there are still many dimensions of vehicles that are not following government regulations, Vehicle Inspection agency that has not implemented BLU-e, and weighbridge units that have not implemented JTO (online weighbridge).

Experience from other countries, according to Rys & Jaskula (2019), the results of studies conducted in Poland showed that most overloaded vehicles violate the heaviest axis load rule by 5%-23%. In China, overload vehicles have increased by 20-50% (Huang et al., 2019). While in the USA (Shatnawi et al., 2018), ODOL vehicles also cause the impact of economic losses, damage to road and bridge infrastructure, safety, and traffic congestion. This study aims to determine the causes of vehicle overload and over dimension so that the leading cause can be known and can make mitigations for the ODOL vehicle. So that the ideal of an ODOL-free Indonesia in 2023 can be carried out properly.

LITERATURE REVIEW

A. Over Dimension

By definition, a violation of dimensions (Peraturan Pemerintah RI, 2012) is a change in the size of the length, width, and height of the main dimensions of a motor vehicle and a loaded tank exceeding the size that has been determined based on applicable regulations. Dimensional violation or over dimension is a condition of the dimensions of a vehicle that is made not in accordance with factory production standards determined by the Government. This means that it has also been modified from the standard state of its dimensions.

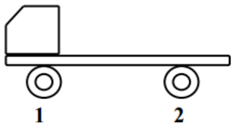
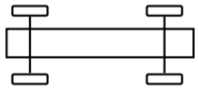
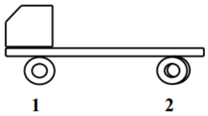
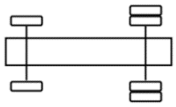
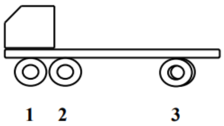
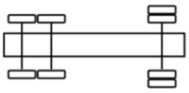
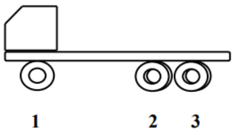
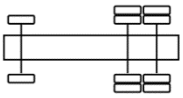
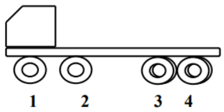
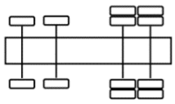
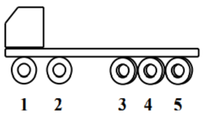
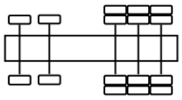
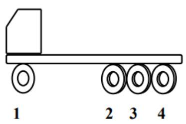
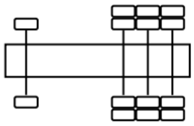
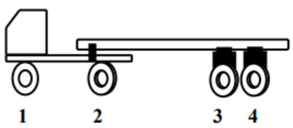
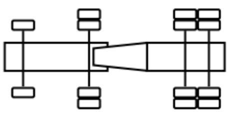
B. Over Loading

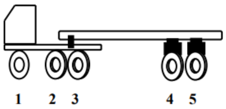
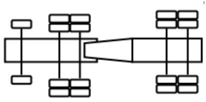
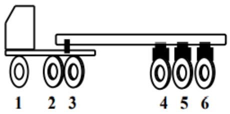
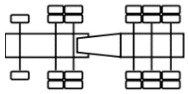
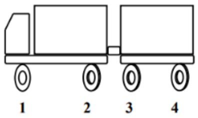
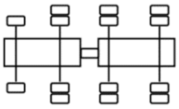
By definition, overloading is the condition that the wheel axis (axle) load exceeds a predetermined load based on the amount of weight allowed. The axis load is adjusted to the vehicle's capabilities, and the road carries capacity based on its class. Meanwhile, according to (Bagui et al., 2013), overloading is the weight of the vehicle axle that exceeds the maximum permissible limit. Overloading means the vehicle loads goods beyond its maximum carrying capacity (Park et al., 2019).

C. Freight vehicles

According to Peraturan Pemerintah RI (2012), a freight transport vehicle is a motor vehicle designed in part or whole to transport goods. Freight Transportation using Motor Vehicles must use Freight Cars. Meanwhile, the axis configuration in freight vehicles is the arrangement of axes and wheels in motorized vehicles. Table 1 describes the types of axis configurations and their figures.

Table 1. Axis Configuration of Freight Transport Vehicles

Axis Configuration	Axis Configuration Image	
	Side	Above
1.1		
1.2		
11.2		
1.22		
1.1.22		
1.1.222		
1.222		
1.2-22		

Axis Configuration	Axis Configuration Image	
	Side	Above
1.22-22		
1.22-222		
1.2+22		

D. Road Class

Based on Undang-Undang No.22 (2009), roads in Indonesia grouped according to class consist of:

1. Class I roads, namely arterial and collector roads that can be passed by Motor Vehicles with a width not exceeding 2,500 (two thousand five hundred) millimeters, a length size not exceeding 18,000 (eighteen thousand) millimeters, a maximum size of 4,200 (four thousand two hundred) millimeters, and the heaviest axis load of 10 (ten) tons.
2. Class II roads, namely arterial, collector, local, and environmental roads that can be traversed by Motor Vehicles with a width of not exceeding 2,500 (two thousand five hundred) millimeters, a length size not exceeding 12,000 (twelve thousand) millimeters, a maximum size of 4,200 (four thousand two hundred) millimeters, and the heaviest axis load of 8 (eight) tons.
3. Class III roads, namely arterial, collector, local, and environmental roads that motor vehicles can travel with a width of not exceeding 2,100 (two thousand one hundred) millimeters, a length size not exceeding 9,000 (nine thousand) millimeters, a maximum size of 3,500 (three thousand five hundred) millimeters, and the heaviest axis load of 8 (eight) tons; and
4. Special class roads, namely arterial roads that can be passed by motor vehicles with a width exceeding 2,500 (two thousand five hundred) millimeters, a length size exceeding 18,000 (eighteen thousand) millimeters, a maximum size of 4,200 (four thousand two hundred) millimeters, and the heaviest axis load of more than 10 (ten) tons.

Table 2. Road Classes in Indonesia

Road Class	Max Width	Max Length	Max Height	Axle Mass Limits
I	2,5 m	18 m	4,2 m	≤ 10,0 ton
II	2,5 m	12 m	4,2 m	≤ 8,0 ton
III	2,1 m	9 m	3,5 m	≤ 8,0 ton
Special	2,5 m	18 m	4,2 m	≥ 10 ton

E. Vehicle Modifications

According to Peraturan Pemerintah RI (2012), it is explained that motor vehicle modification is a change to the technical specifications of the dimensions, engine, and/or carrying capacity of Motor Vehicles. Modifying motor vehicles must be carried out by a general workshop of motor vehicles appointed by the Minister responsible for the industrial sector. Provisions for Motor Vehicle Modification include:

1. It can only be done after getting a recommendation from the sole agent of the brand holder,
2. Mandatory to be carried out by a general workshop of Motor Vehicles appointed by the Minister responsible for the industrial sector,
3. It is mandatory to have a Type Test registration certificate,
4. Dimensional modifications can only be made on the extension or shortening of the runway (chassis) without changing the axis distance and construction of the Motor Vehicle,
5. Modification of the engine is carried out by replacing the engine with a machine of the same brand and type,
6. Modifying carrying capacity can only be carried out on Motor Vehicles by adding the rear axis without changing the distance of the original axis. The added axis must have the same material as the original axis and be calculated according to the carrying capacity of the road traveled.

RESEARCH METHOD

This type of research is carried out using quantitative descriptive research. Descriptive research is a method aimed at describing existing phenomena which occur today or in the past. This research also uses quantitative research because data processing and analysis are displayed in numbers accompanied by tables and figures starting from data collection. In this study, data collection was carried out using the triangulation method. Triangulation of techniques means that researchers use different data collection techniques to obtain data from the same source. Researchers use observation, interview, and documentation methods for the same data source in unison. The population in this study was all vehicles entering the Trosobo Weighbridge.

Meanwhile, the sample is a vehicle that experienced ODOL when weighed on the Trosobo WeighBridge. The tools used for this survey are portable load axles and meters. Weighing is carried out to determine the vehicle's total weight and the weight of each vehicle's axis (Liu et al., 2022). Furthermore, a dimensional measurement survey was carried out to determine the size of the vehicle's dimensions and the dimensions of the payload. The following is the researcher's documentation for weighing surveys and dimension measurements. Determination of the sample using the Slovin formula, the calculation of the sample with an error tolerance limit of 10%.

$$n = \frac{N}{1 + Ne^2}$$

where:
n: Number of samples
N: Total population
e: Fault tolerance limit (10%)

Based on the formula above, the number of vehicle samples entered at Trosobo Weighbridge will be used in the study with vehicles as many as 4,600 vehicles/month, and a tolerance limit of 10% is as many as 100 vehicles. In this study, the authors used nonprobability and accidental sampling techniques. Univariate analysis is used to obtain an overview of the frequency distribution and proportion of dependent and independent variables. Univariate analysis is presented in the form of graphs and tables. Data analysis is intended to get an overview of motorized vehicles that carry outweighing, such as:

1. Vehicle axis configuration;
2. Violation of dimensions and loads on freight vehicles, to calculate the percentage used the formula:

$$P = \frac{X}{N} \times 100\%$$

Where,

P= Percentage

X= Number of events in respondents

N= Total number of respondents

3. Types of vehicles that often commit violations of dimensions and loads;
4. Types of commodities transported;
5. Modifications made;
6. The speed of the driver when driving the vehicle;
7. Opinions regarding the control of ODOL vehicles.

Bivariate analysis to explain the relationship of independent variables to dependent variables. The independent variable in this study is motor vehicle modification, while the dependent variable is a violation of ODOL vehicles. The relationship between violations of ODOL vehicles and modifications of motor vehicles is presented in the form of a cross table. Here is the calculation formula for Chi-Square.

$$x^2 = \sum_{i-l}^{r} \sum_{j-l}^{c} \left[\frac{\left(O_{ij} - E_{ij}\right)^2}{E_{ij}} \right]$$

Where:
r: number of rows
c: number of columns
i: line to i
j: line to j
O_{ij}: the frequency of observation in row I of column j
E_{ij}: expected frequency in row I of column j

FINDINGS AND DISCUSSION

Researchers conducted a 14-Day survey at the Trosobo Weighbridge to obtain samples of 100 vehicles. The sample is an ODOL vehicle weighed on the weighbridge.

1. **Dimensional Violation**
   Figure 1 shows the analysis results of a sample of 100 vehicles; 20 vehicles committed violations of the main dimensions. This result suggests that the violation of the main dimensions is classified as very low. It can be seen in the picture above that a pickup freight car with a configuration of 1.22 suffered a violation of the main dimensions because it violated the total length of the vehicle. The standard total length of the vehicle is 9.01 m, but in the condition when measured, it has a length of 9.67 m, so it experiences an excess length of 0.66 m.

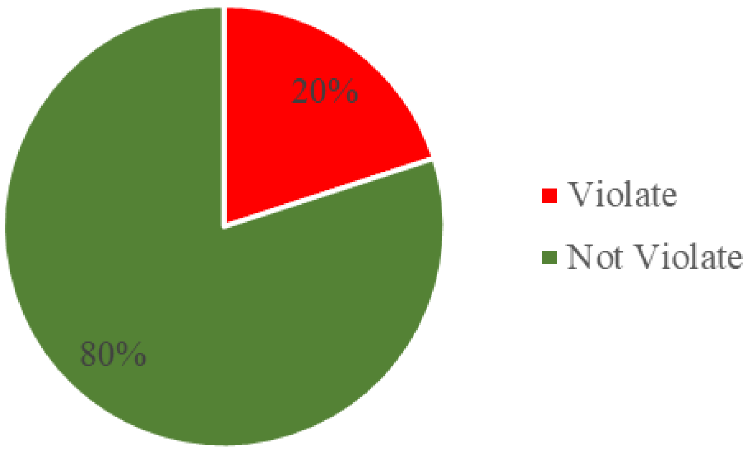


Figure 1. Vehicle Dimension Violation

Figure 2. Vehicle Over Dimensions

2. Over loading violations

The total number of sample vehicles that carried out the weighing was 1564, and the number of vehicles that violated the load was 224.

Table 3. Over Loading Violations

No.	Range of Violations (%)	Number of Vehicles	Presented	Category
1	5 – 25	151	67%	High
2	25 – 50	36	16%	Very Low
3	51 – 75	21	9%	Very Low
4	76 - 100	10	4%	Very Low
5	> 100	6	3%	Very Low
	Amount	224	100%	

From Table 3, it can be explained that the highest percentage of charge violations in the range of offenders is 5% - 25% of the number of 151 vehicles, and the lowest violation rate in the range of violations is more than 100% of the number of 6 vehicles.

3. The Relationship of the modification with the violation of ODOL

Based on Table 4, it can be explained that there is a tendency for vehicles that experience ODOL violations with overload < 50% not to make modifications. Of the 65 vehicles that experience ODOL violations with an overload of < 50%, 83.1% do not modify vehicles, while the remaining 16.9% make modifications. On the contrary, there is a tendency for vehicles that experience ODOL violations with overload > 50% to make modifications. Of the 35 vehicles, only 5.7% did not make modifications, and most of the others, namely 94.3%, made modifications. In other words, there is a high linkage between the low percentage of overload of ODOL vehicles to ODOL vehicle modifications.

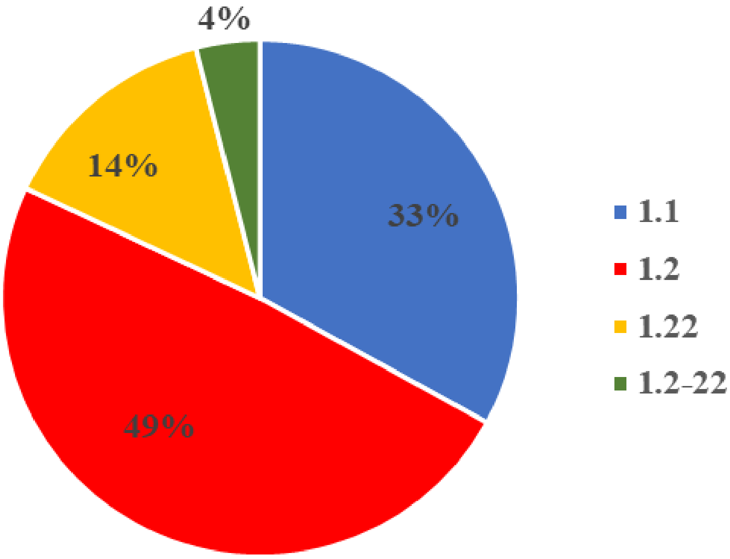


Figure 3. Vehicle Overloading Axis Configuration

Table 4. Crosstabulation Analysis

Modification * ODOL Crosstabulation

			ODOL		Total
			overload <50%	overload > 50%	
Modification	No	Count	54	2	56
		Expected Count	36.4	19.6	56.0
		% within ODOL	83.1%	5.7%	56.0%
	Do	Count	11	33	44
		Expected Count	28.6	15.4	44.0
		% within ODOL	16.9%	94.3%	44.0%
Total	Count	65	35	100	
	Expected Count	65.0	35.0	100.0	
	% within ODOL	100.0%	100.0%	100.0%	

Table 5. Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	55.259[a]	1	.000		
Continuity Correction[b]	52.164	1	.000		
Likelihood Ratio	62.747	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	54.706	1	.000		
N of Valid Cases	100				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.40.

b. Computed only for a 2x2 table

Based on the results of the Chi-square analysis in Table 5, it is known that the chi-square value is 55,259 with a p-value of 0.000 which can be seen in the Asymptotic Significance (2-sided) column. Based on this, there is a relationship between ODOL violations and vehicle modifications at a significance level of 1 % (P-value < α = 1 %).

The results of this study show that vehicles experiencing ODOL as much as 20% of the total sample 100%; this is in line with the research carried out by (Trzciński et al., 2018). The largest overloading violation is < 25%, as many as 151 vehicles or 67%, and what is quite surprising is that there are load violations up to > 100%; there are six vehicles, or about 3% of the total sample. This finding is very important considering that the Indonesian Government targets an ODOL-free Indonesia by 2023, where real action is needed to reduce ODOL vehicles so that the impact of ODOL vehicles, including damage to road and bridge infrastructure, congestion, air pollution, traffic accidents, can be avoided.

CONCLUSION AND FURTHER RESEARCH

In this paper, the author shows that the condition of ODOL vehicles for dimensional violations can be classified as low and even very low. Vehicles that extend and/ or raise the tailgate of goods on their vehicles cause overload and decrease the vehicle's performance, potentially causing accidents. In this study, there were findings that there was a significant relationship between dimensional violations in the form of adding the primary dimension and charge violations. Vehicles that perform Over dimension are also ensured to be overloaded. Concrete action is needed from the Indonesian Government to bring order to vehicles carrying ODOL to create traffic safety on the road. The results of this study were only carried out on the Trosobo Weighbridge and could not be applied in general throughout Indonesia. Suggestions for further research can be tested on the load distribution on each axle for ODOL vehicles to see how much load each axle will receive against road damage.

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