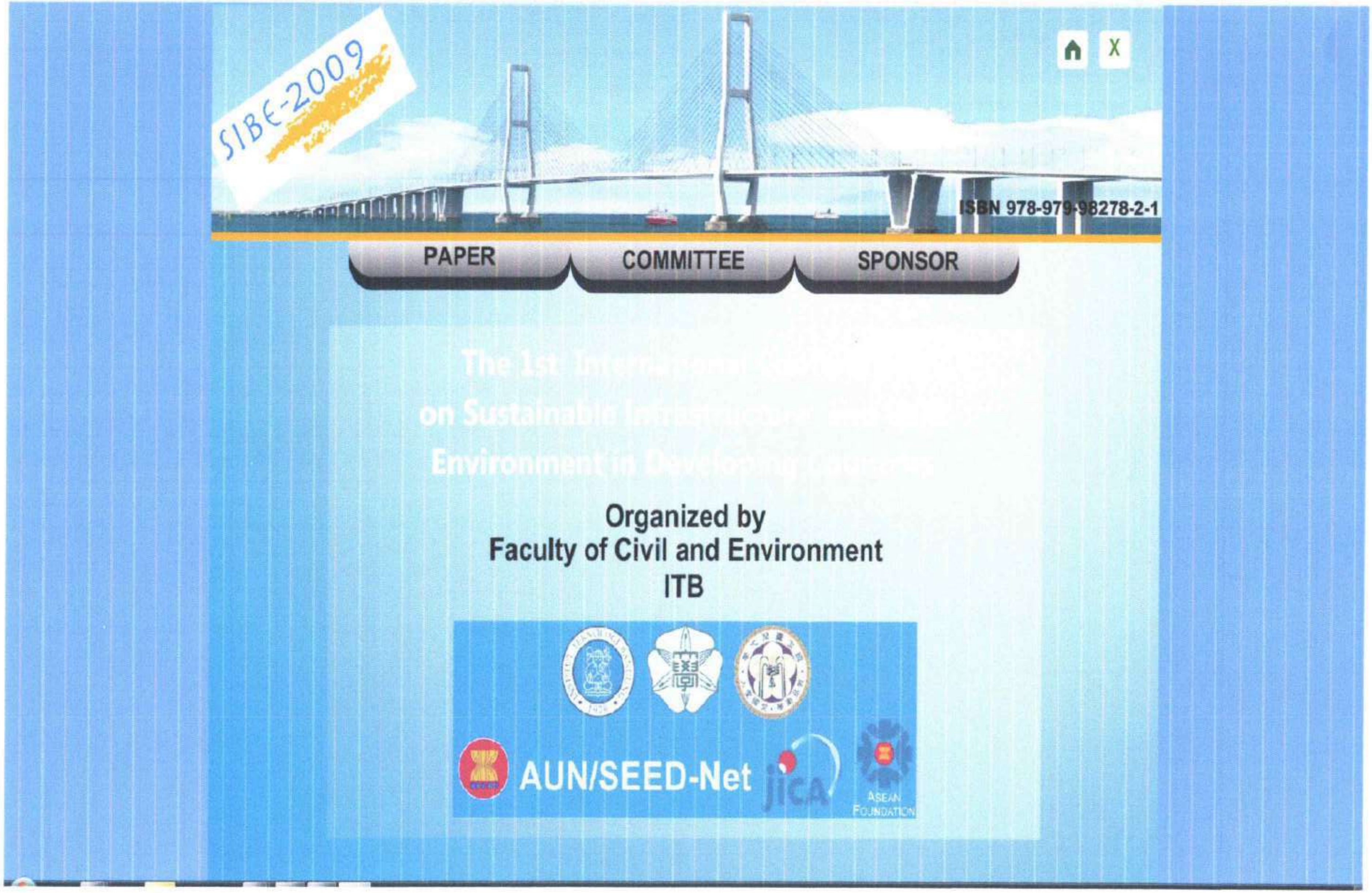
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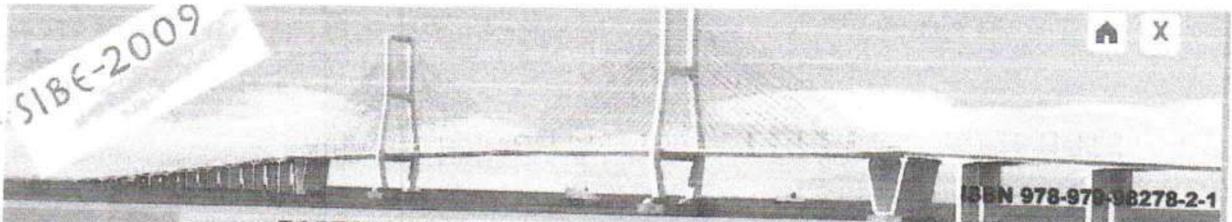

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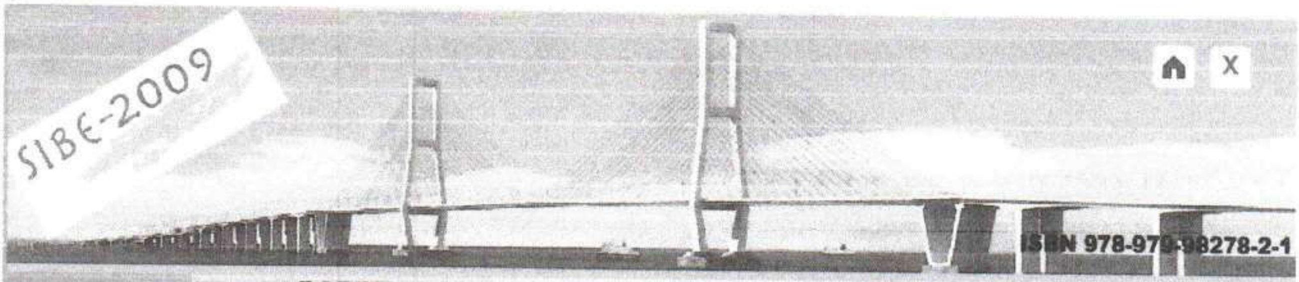

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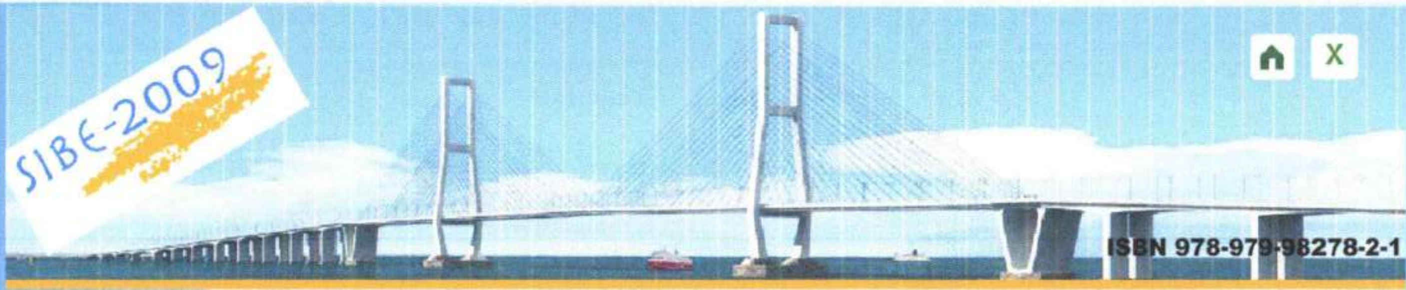

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Sustainable Transport Infrastructure through Multimodal Freight Transportation Policy

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***Abstract*:**
More than 90% of freight movement in Indonesia is carried by land transportation (mostly highway mode). There are Rail network in Java Island and some parts of Sumatra Island, so multimodal/inter-modality system can be applied. In fact, lack of sea and rail transportation infrastructure and management makes highway mode is still the main choice among other transportation modes. This study is conducted in relation to the impact of overloading truck in freight transportation system in Indonesia, because the government is still allowing tolerance up to 50 percent to the normal load for each truck. Overloading have a big impact to the maintenance of the road and will influence to road maintenance budget and sustainability of road. In the long run, multimodal freight transport should be the right way not only in saving of infrastructure maintenance budget, but also in total transport costs and sustainable of transport infrastructure. Case study in the Eastern corridor of Aceh Province, because the government had decided to revitalize of the existing railway in order to anticipate freight movement in future. This study is to analyze the effect of overloading trucks to the road performance at the existing condition and comparing to the multimodal scenario. The result shows that the multimodal freight transportation is the best way both in sustainable infrastructure and total transport cost.

Keywords: freight transportation, maintenance cost, multimodal road, overloading.

1. Background

Lack of attention to the freight movement by sea and rail mode, mainly lack of infrastructures, facilities, systems, and regulation, therefore freight movement by road mode is still the best choice by shippers because more efficient. It choice influences the traffic load on the road network and accelerates the road deterioration. Moreover, the government is still allowing 50% tolerance for truck over the standard tonnage.

A strategic role of road network is not only in transportation of people and goods, but also in social live, economic, art and security in the nationwide. It can bee seen from a big hope of the society to the road network in giving safety and comfortable for movement. On the other hand, road condition decline as the increase of time, and many heavy trucks tend to overloaded. In reality, the weighing bridge is a place where trucks with overloading should be measured. In the decentralization era, there are many local governments used weighing bridge to generate their *regional gross domestic product*, GDP (Media Indonesia, August 4, 2004). Land Transportation Organization (Organda) stated that illegal taxes levied to the freight transportation (trucks) more or less 18 trillion rupiahs per year (Liputan 6 pagi SCTV, Wednesday 21, 2007). Besides, legal tax levied for trucks movement is more or less 50 trillion rupiahs. Comparing to road maintenance budget for routine and periodic maintenance of national road was spent about 5.1 trillion rupiahs in the year 2006, this amount is only about 30 percent of illegal levied and about 10 percent of legal levied which is allocated for road maintenance and rehabilitation.

This paper is to present the impact of overloading truck in freight transportation system in Indonesia to keep the road construction sustain to the design life, because the government is still permit tolerance up to 50 percent to the normal load for each truck until midyear 2008. We expect this paper to lay a foundation for further investigation and research concerning to overloading and application of multimodal freight transportation.

2. Problem and Literature Review

Daily Kompas (February 14, 2008) released the comment from head of the Directorate General of Bina Marga, the Department of Public Work that road deteriorations happened faster than life time design because of overloading. The overloading tolerance has been given to operator in carrying goods up to 50 – 60 percent from normal permitted until midyear 2008. This meant that the road pavement is designed of single axel load 8 to 10 tons is permitted to be loaded up to 16 tons. Within this tolerance, the vehicle damaged factor (VDF) will be multiplied by 6.5 times to the normal load.

For the preliminary data analysis, the 4^{th} power equation is used. The fourth power index means that with a two fold increase of the axel load the loading effect on pavement is increased sixteen-fold, (Bina Marga, Department of Public Work, quoted from AASHTO'72).

$$\text{ESAL} = \left[\frac{P}{8{,}16}\right]^4 \tag{1}$$

where ESAL stands for equivalent standard axel loads; P is axle load (ton); 8.16 is a standard axle load. Let us calculate the damage to the road pavement based on Bina Marga equation.

$$\text{CESAL} = \sum_{Traktor,Trailer}^{passenger-car} \text{m x 365 x ESAL x C x N} \tag{2}$$

Where CESAL stands for cumulative equivalent standard axel loads; m is the number of each type of vehicle; 365 is total day in a year; C is vehicle coefficient distribution; N is the correlation of design life of pavement and growth rate of traffic.

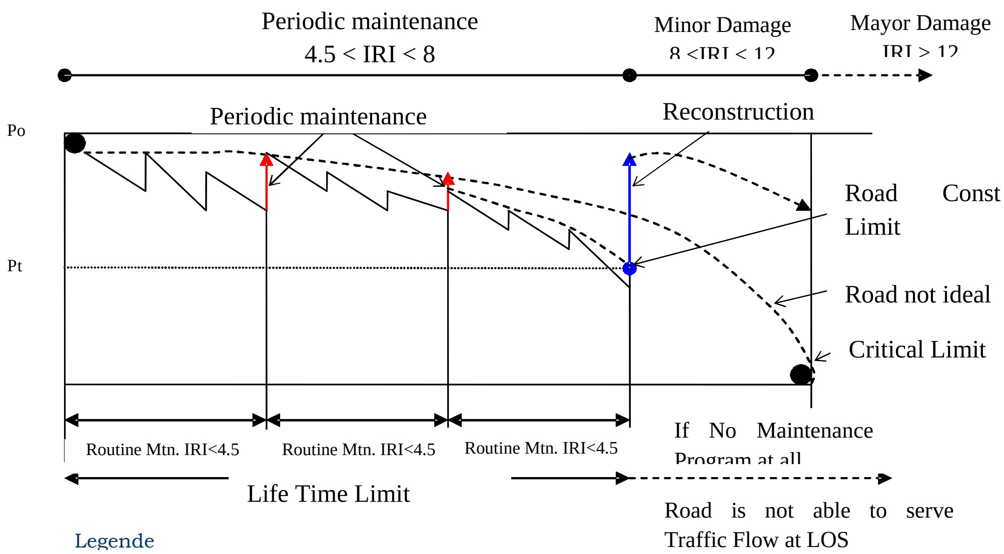
To keep the road construction sustain to the design life, and maintenance budget, it is needed to introduce a policy on multimodal freight transportation system by sharing rail mode and sea mode instead of the only by road mode.

The use of several modes of transport has frequently occurred as goods which are shipped from the producer to the consumer. When several modes are used this is referred to multi-modal transport (point to point network), even though inter-modal is possible. What distinguishes inter-modal from multi-modal is that the former involves the use of at least two different modes in a trip from origin to destination under a single transport rate (Rodrigue, et al, 2004).

Multi-modal and integrated inter-modal freight transportation system is a system that purpose to serve trade with giving or offering the simplification in shipping and handling goods. The simplification is directed not only to the shipper and carrier, but also to the receiver of goods in the destination in order not to have complexity of handling process (Tamin, 2000).

Maintenance activity is the whole activity directed to road in order to have a good service as a plan in the design criteria. In the maintenance activity, there are two activities as mention below.

1. Routine maintenance, this action should be done continuously along the year to handle minor road deterioration such potholes, cracking, and clearing side ditch and so forth. In this step, include routine maintenance and periodic maintenance are very useful to keep serviceability index, as can be seen in figure 1.
2. Strengthening of pavement structure, this happened if a periodic maintenance is late or out of time, and damage has occurred to the road foundation. This activity will increase road serviceability to the good condition.



Legende

Po : Initial Service Ability Index (PHO)

Pt : End of Service Ability Index (life time limit)

Po and Pt depend on road classification (N, P, K) and AADT

.

Figure 1 Correlation between road condition, life time and type of maintenance

Figure 1 illustrated the correlation between road condition, life time and type of maintenance. Basically, the determination of minimum road condition is in average, the International Roughness Index (IRI) at level 4.5 to 8 m/km the road should be in the periodic maintenance level

3. Simulation Method

There are six scenarios in this simulation. There are three scenarios in a single mode, only road mode operated. The other three are multimodal scenarios as can be seen in table 1 as follow.

The predictions of movement of goods for all scenarios above are based on OD matrices for 20 years (the period of analysis), where the volume of goods and passenger movements which affect the traffic load is the same (Sofyan et.al, 2009). Thus the number of vehicles DN scenario will be different with DS-1, and DS-2, although still using a single-mode (road mode). Especially for the road mode, with a number of different trucks and vehicle damage factor (VDF) is different, it will influence the amount of cumulative ESAL and IRI, which resulted in a change of maintenance and costs recovery vary over time period of analysis.

After implementing a multimodal scenario, (DS-3, DS-4, and DS-5), differences in cumulative ESAL values and IRI will be more different, because it is assumed that some goods to be switched 20% to the train mode, and switched 10% to the sea mode. The goods to be transferred to rail and sea modes especially for heavy items materials like building materials, and other heavy materials.

Table 1 Six scenarios in simulation on East corridor of NAD province

No	scenario	Notation	legend
1	Do Nothing (road mode)	DN	Movement of goods by truck loaded according to the survey results at weigh stations Semadam (NAD-SUMUT Borders).
2	Do Something 1 (road mode)	DS-1	scenario in which each type of trucks loaded 50% more than the permitted number of load (JBI).
3	Do Something 2 (road mode)	DS-2	scenario where the maximum load of each truck in accordance with the amount of allowable load (JBI)
4	Do Something 3 (Multimodal)	DS-3	Two-modes (Roads and Railways) once operated, but the sea modes was not charged.
5	Do Something 4 (Multimodal)	DS-4	Two-modes (road and sea modes) once operated, but not the train modes charged
6	Do Something 5 (Multimodal)	DS-5	Three modes (road, railways, and sea) once operated..

At the beginning of the road operation a pavement index as International Roughness Index (IRI) is assumed to be 2.0. By the time operation followed by traffic load and weather, the road condition will decrease. Determination of pavement index based on Indonesian Integrated Road Management System (IIRMS), the formula used as follow;

$$\mathbf{RI_t = (RI_0 + 725\ (1+SNC)^{-5}\ .\ NE_t)\ e^{0.0153t}} \qquad (3)$$

Where;

RI_t = roughness index at t, IRI (m/km)

RI_0 = initial roughness index, IRI (m/km)

NE_t = Number of **E**quivalent **S**tandard **A**xel **L**oad (ESAL) at t (per 1 million ESAL)

SNC = *Modified Structure Number Capacity* depend on pavement type

The road construction in this case is flexible pavement with an average 7.0 meter in wide, and assumed that the initial IRI is 2,0. Other assumptions are;

- ¤ 0<IRI<4,5 is routine maintenance and 4,5<IRI<8 is periodic maintenance

- ¤ The cost of routine maintenance is 41.85 million rupiahs/Km and periodic maintenance (Overlay)is about 747.35 million rupiahs/Km (Dept. of Public Work, 2007)
- ¤ Traffic growth is assumed 6 percent per year

4. Analysis And Simulation

Based on a simulation in a simple network of a multimodal movement (by rail, road and sea modes) with the assumption that infrastructure for those modes are available and in accordance to the capacity planning, but for road mode is simulated for three conditions, existing (DN), 50 percent overloading (DS-1) , and normal load (DS-2). After implementing the multimodal scenario, presumed that there is no more overloading on the road mode.

Based on the performance of road networks from the three scenarios before implementing multimodal scenario described above, it can be predicted recovery cost for handling road maintenance per kilometer is higher compare to the others three multimodal scenarios as can be seen in figure 2 as follow.

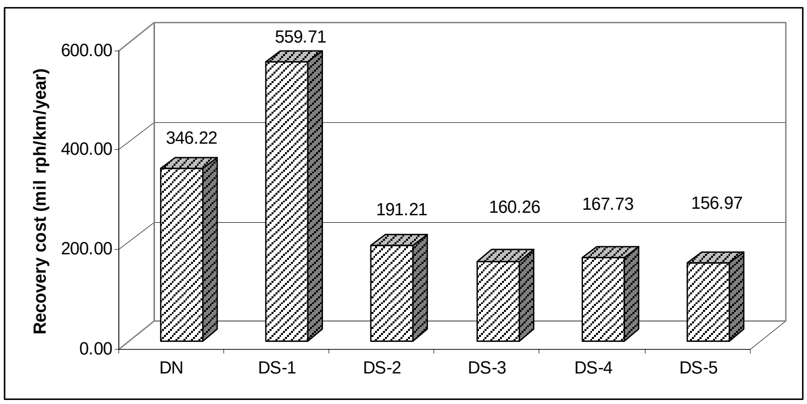


Figure 2 Comparison average road maintenance cost among 6 scenarios

The lowest recovery cost for road maintenance per kilometer per year is scenario DS-5. This meant that implementing multimodal freight transportation (DS-5) can save budget 220% compare to DN and 357% compare to DS-1. Saving budget in this case is meant that infrastructure (mainly road pavement) can be sustained as it is in the design life.

For Further calculation of the total transport cost for all six scenarios on the Eastern corridor of NAD province is showed in table 2 as follow.

Table 2 Comparison the total transport cost in 20 years period

Scenario	Cost prediction (Milyar rupiah) in 20 years period (Present value at discount rate 12%)						
	Infrastructure recovery cost	pasenger tariff	freight tariff	passenger Time value	Freight time value	freight transshipment	Total costs
DN	990.51	1,299.28	29,849.34	423.27	1,787.86	-	34,350.27
DS-1	1,625.41	1,299.28	29,849.34	353.94	1,477.01	-	34,604.99
DS-2	531.87	1,299.28	29,849.34	549.39	2,302.93	-	34,532.82
DS-3	490.05	1,201.65	26,452.66	392.37	1,580.79	252.88	30,370.40
DS-4	469.91	1,299.28	26,530.24	461.54	1,890.39	293.96	30,945.33
DS-5	481.43	1,201.65	26,110.50	380.74	1,536.36	385.92	30,096.61

Multimodal freight transport is not only saving the infrastructure recovery cost, but also in the total transport cost as shown in table 2 above.

5. Conclusion

1. Truck overloading up to 50 percent (DS-1) influence the decreasing of the life time road pavement, and increase the vehicle damage factor approximately 5 times. This can increase the budget for periodic maintenance triple in a design life time.
2. The government should spend about 559 million rupiahs per kilometer per year for DS-1 and 346 million for DN. Implementing multimodal scenario (DS-5) it is only 157 million rupiah per kilometer per year, it meant that DS-5 much lower than DS-1 and DN.
3. The government should review the role of overloading tolerance to be zero, and push the shippers and operators of freight with the multimodal/inter-modal system to keep the sustainability of transport infrastructure mainly road network.

6. Acknowledgment

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