Timber transportation using two types of trucks in industrial plantation forests, North Sumatra, Indonesia

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Abstract. The timber transportation is expensive, because wood besides having a light weight, is also deep implementation is often constrained by limited access, steep slopes and distances far away. The purpose of this study was to determine the productivity of timber transportation in industrial plantation forests of PT. Toba Pulp Lestari, North Sumatra, Indonesia. This research was conducted in the area of PT. Toba Pulp Lestari, North Sumatra, Indonesia. The research was carried out by taking a sample of twenty trucks with two different types of trucks by purposive sampling. The results showed that the shortest working time in activities transportation is the activity of unloading. The average volume capacity of truck was 10 m$^3$ and 32 m$^3$, respectively. The results of this study indicate that the average productivity produced by both types of trucks was 0.57 m$^3$/hour and 1.46 m$^3$/hour, respectively.

1. Introduction

Using trucks for timber transportation has several advantages, namely trucks can operate swiftly and speed is relatively high. However, besides that there are some weaknesses include: relatively small haulage per trip, needing a lot of tools and food long load time in a large operation, requires large capital, cost repair and maintenance as well as large spare parts [1][2][3].

The farther the distance transport, the larger the fleet needed. On short distance transport, loading is a relatively large work element when the number of vehicles greater than optimum, the waiting time will be longer. This means productivity becomes lower. Furthermore, it was stated that the vehicle the most economical in a company is determined by capacity transportation, loading capacity and loading, transport distance and the state of the road [4].

Slippage as one of the obstacles in the timber transportation. Research of the timber transportation is very important, if the wood is late transported out of the forest, the quality of wood decreases due to weather and lots of mold [3]. This affects the selling price of wood. Smoothness is needed in transporting wood. As a result of slippage, productivity transportation of wood is not optimal so that the production costs of transportation become expensive. Cost post for transporting wood is expensive [5].

Overall factors that affect productivity of log transportation using trucks, namely transportation time, hauling distance, truck speed and volume of wood transported [6]. Besides the low volume of truck capacity and long haul distances, topographical factors influence the average productivity of transporting wood [7]. The condition of the sloping and steep area make it difficult for trucks to pass the road uphill and downhill with conditions loaded with wood.
Transporting wood is an important timber harvesting activity. Log transportation is the time required by the truck for remove wood from the landing until the wood is regulated at the log yard. Effective time is the time used by truck to transporting wood from loading point on the edge of the forest to the place wood processing. Meanwhile, total time is the total amount of time which is used to transport wood, which consists of effective time transportation and other time [8].

The purpose of this study was to determine the productivity of timber transportation in the industrial plantation forest of PT. Toba Pulp Lestari, North Sumatra, Indonesia.

2. Methods

This research was conducted in the Industrial Plantation Forest of PT. Toba Pulp Lestari, North Sumatra, Indonesia. The equipment used in this study were Fuso FN trucks 527 ML and Mitsubishi Colt Diesel Canter FE 74 HD used for transporting wood, stop watch that works for measure the time element used in transportation, which stationery function to record the calculation data obtained into the tally sheet, Microsoft Excel that is used to process data, digital cameras serves to document the research activities carried out, tally sheet that serves to summarize the data needed in research.

Sampling was using twenty trucks with two types of trucks different by purposive sampling, with ten times each transportation trips using Fuso FN 527 ML trucks and Mitsubishi Colt Diesel Canter FE 74 HD. The minimum sample to take is ten times the number of variables to represent the data. Usage amount Different samples from the same population do not produce a difference means it. The results from a sample of only two percent are not much different from the results which uses a sample of ten percent of the population. Based on the description above, it is possibly determine a sample size certain that can be declared the most suitable or best for a study. Although there are formulas that can be used to estimate size the required sample, but the size of the sample obtained is only is a guideline, is not an absolute requirement [9].

The type of data collected includes primary data and secondary data. Data The primary is done by direct observation in the field in the form of distance data transportation of wood expressed in kilometers (km), the volume of wood that is transported (m$^3$) and working time of transportation. While secondary data collected from reports or company archives in the form of a general picture company, the price of transportation, the life of the truck for transportation, interest capital in percent (%) per year, and operator (driver) wages.

3. Results and discussions

3.1. Timber transportation

Transporting timber from the logging area to the HPHTI log pond PT.Toba Pulp Lestari is carried out by land using Fuso FN trucks 527 ML and Mitsubishi Colt Diesel Canter FE 74 HD. Tables 1 provide a comparison of the specifications of the two types of trucks Mitsubishi Fuso FN 527 ML and Mitsubishi Colt Diesel Canter FE 74 HD used in transportation activities in the HPHTI PT. Toba Pulp Lestari Aek sector Nauli.

| No. | Specification            | Unit | Canter FE 74 HD | Fuso FN 527 ML |
|-----|--------------------------|------|-----------------|----------------|
| 1   | Vehicle length           | mm   | 5,960           | 8,515          |
| 2   | Vehicle width            | mm   | 1,970           | 2,460          |
| 3   | Vehicle height           | mm   | 2,145           | 2,750          |
| 4   | Maximum speed            | Km/hour | 110     | 76             |
| 5   | Incline with max G.V.W  | Tan  | 37              | 44.5           |
| 6   | Year of buying           |      | 2013            | 2013           |
Table 1 showed that truck specification of these two types can be known. The trucks were the Mitsubishi Colt Diesel Canter FE 74 HD has an overall length of 5.9 meters, 1.9 meters wide, and 2.1 meters high while the Mitsubishi Fuso FN 527 ML has a length of 8.5 meters, a width of 2.4 meters and a height of 2.7 meters. Length and width and truck height affects the dimensions of the truck's transport volume. Besides the use of conveyances the most important thing is availability of the number of trucks needed.

Number of trucks needed adjusted for the large amount of wood to be transported. If wood is transported a lot then the number of trucks needed is also large but, if the amount of wood to be transported is small then the number of trucks transporting as well a little. This is because to reduce unnecessary operations so can be more efficient. [10] stated that the availability of the number of dump trucks and loading equipment is a matter which is very sensitive to the continuity of production. Excess fleet amount will result in operating expenses to swell, while the amount a small fleet will reduce the amount of production. Ideal conditions inside the process of loading and transporting material is very difficult to achieve.

Timber transportation is carried out to move wood that has been taken felled and skidded to the location of wood processing [11]. This transportation activity has a work risk high because of the steep path [12]. Stated that timber harvesting is a process of transferring forest products in the form of wood. Activity timber harvesting is an activity that raises the risk of work accidents and environmental damage [11], [13].

The timber transportation activity starts after the felled wood is cut and collected in advance on the edge of the forest near the transport road. This wood collection is carried out with the aim of gathering wood at the edge of the forest This is to facilitate the process of loading and transporting wood. First the pile of wood is loaded onto a transport truck using a tool fit mechanical wood. Then do the wood arrangement and binding of the load wood so that wood is arranged neatly and safely (not splattered) when transported. The two types of trucks used are Fuso FN 527 ML truck brands and the Mitsubishi Colt Diesel Canter FE 74 HD. Most of these transport trucks not owned by the company where the research is but belongs to the contractor and the company only hires them during activities timber transportation takes place. Therefore, truck specific data, such as year manufacturing, equipment prices, even truck rental prices are not available in full [14].

However, based on direct observations in the field and interviews with the truck driver some secondary data can be obtained. Trucks with Fuso FN 527 ML and Mitsubishi Colt Diesel Canter FE 74 HD each with a maximum capacity of 10 m³/trip and 32 m³/trip.

3.2. Working time

Timber transportation observation activities are carried out from the place wood stockpiling (landing) to a timber collection point (log yard). Elements of work are observed include empty running time, load time, loading time, time not effective (idle time). Observations on average of percent of total time transportation by truck can be seen in Table 2.

| No. | Working element       | Average of working time (hour) | Percent (%) |
|-----|-----------------------|-------------------------------|-------------|
|     |                       | Canter FE 74 HD               | Fuso FN 527 ML | Canter FE 74 HD | Fuso FN 527 ML |
| 1   | Oncoming vehicle      | 2.31                          | 3.10         | 27.97          | 28.74          |
| 2   | Loading               | 1.15                          | 1.30         | 13.92          | 11.64          |
| 3   | Charged vehicle       | 4.12                          | 5.98         | 49.88          | 53.54          |
| 4   | Uploading             | 0.68                          | 0.68         | 8.23           | 6.09           |
|     | Total                 | 8.26                          | 11.17        | 100            | 100            |
Table 2 showed that the shortest working time in activities transportation is the activity of unloading cargo with an average time 0.68 hours on both types of trucks which is about 8.23% on the Canter FE 74 HD truck and 6.09% on the Fuso FN 527 ML of the total time. Average volume capacity used in transportation activities were 10 m³ and 32 m³, respectively. This is caused by uploading activities it is just a chain opening and tarpaulin, weighing the truck and the time to unload Next the lowest is when loading wood by truck an average of 1.30 hours on Fuso FN 527 ML trucks around 13.92% and 1.15 hours on the Canter FE 74 HD truck around 11.64% of the total time spent in wood transportation activities. The time of this activity is slightly greater than dismantling activities. It is caused by the operator is difficulty in tidying wood inside the truck. It is arranged parallel and there is no excessive length log on the truck. It can cause interference during transportation, installing tarpaulins and tie the chain on a truck [15]. Stated that heavy equipment productivity is in fact at the field is not the same when compared to the ideal condition of the tool due to things such as topography, operator expertise, operation and maintenance tool. In this study, the amount of time to load and unload wood influenced by several factors including: the amount of wood volume, the number of logs, road spacing, conditions and area of loading and uploading, as well as human factors (labor) which influenced by the conditions of workers, skills and experience of personnel work [16].

Ineffective timber transportation time that occurs in wood transportation activities what can be avoided are: preparation of the truck before leaving for the location, interference with the operator to meet their needs such as take a meal break, urinate and ask for a permit to transport. While the effective time that can be avoided is the time interval that occurs between transport activities per transport trip, waiting to be loaded and unloaded, break the operator, and raise logs.

3.3. Timber Transport Productivity

The productivity of timber transportation using trucks is described as the ability of trucks to transport wood (m³) over a certain hauling distance (km) per unit time (per hour) or expressed as m³/hour. In Table 3 presented data on the results of timber transportation activities with two types of trucks operated in the industrial planting forest of PT Toba Pulp Lestari areas.

| No. | Type of Truck    | Working Time (hour) | Distance (Km) | Volume (m³) | Productivity (m³/hour) |
|-----|------------------|---------------------|---------------|-------------|------------------------|
| 1   | Canter FE 74 HD  | R: 14.01-15.36 A: 14.30 | R: 65-67 A: 66.20 | R: 7.84-8.97 A: 8.34 | R: 0.53-0.61 A: 0.57 |
| 2   | Fuso FN 527 ML   | R: 21.36-22.16 A: 23.36 | R: 65-66 A: 65.40 | R: 29.81-31.69 A: 30.63 | R: 1.38-1.55 A: 1.46 |

The average volume of timber transportation using Canter FE trucks 74 HD and Fuso FN 527 ML were 8.34 m³/trip and 30.63 m³/trip, respectively [17]. Stated that productivity obtained with a distance of 60-61 km and a transport volume was 37.78 m³/trip (1.65 m³/hour). The size of the volume of wood transported depends on the capacity of the trucks used which will ultimately affect productivity tools used. Average dimensions of truck length, width and height Canter FE 74 HD types are 4.5 m, 2.5 m and 1.1 m, respectively. Average dimensions of Fuso trucks are FN 527 ML dimensions of length, width and height are 9 m, 2.4 m and 2.2 m, respectively.

It is stated that with dimensions of length 11.50 m, width 2.50 m, and 3 m high, a truck can transport 57.79 m³ of wood whereas with dimensions of length 11.50 m, width 2.50 m; 2.50 m high can be transporting wood as much as 48.6 m³[18]. The average distance traveled by the Canter FE 74 HD and Fuso FN trucks 527 ML was 66.20 km and 65.40 km, respectively. Distance this journey is measured from the place of transporting wood on the edge of the forest to the place processing (in factories).
Average productivity of using wood transportation the Canter FE 74 HD and Fuso FN 527 ML trucks was 0.57 $m^3$/hour and 1.46 $m^3$/hour, respectively. The average productivity of wood transportation use the Canter FE 74 HD and Fuso FN 527 ML trucks if changed with units of $m^3.km/hour$ was 65.77 $m^3.km$ / hour and 179.91 $m^3.km$ / hour, respectively.

The volume of timber transported is an important factor is the cost involved [19]. The volume of wood depends on diameter and length of the stem. The greater the diameter and length of the stem the volume of wood will also be even greater. This volume will be influential later the productivity of work produced will also be greater and the costs are issued for one log will be low. The hauling distance itself is one of the important variables in productivity of transportation work [20]. In transportation of wood in the field distance economical transportation is the first choice because of the economical hauling distance will lead to high productivity resulting in the cost of transporting wood issued will be lower [21][22]. This is consistent with [23] stated that truck performance is influenced by several factors related things such as transport distance, road quality, truck speed, number load, type of truck, number of trips, rain, number of hours worked or working days, skills, system wages and work systems.

4. Conclusions

In this study, the average productivity of using timber transportation the Canter FE 74 HD and Fuso FN 527 ML trucks was 0.57 $m^3$ / hour and 1.46 $m^3$ / hour, respectively. Thus the difference in the productivity of the conveyance is largely due to the driver factors such as skills, age and work experience. This matter in accordance with the statement of the results of the productivity calculation of forest harvesting for each activity was different.

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