Effect Of The Engine Capacity Improvement Upon The Log Skidding Productivity Under The Monocable System At PT. Ratah Timber Company, Kalimantan Timur, Indonesia

Ruspita Sihombing, Martin Surya Putra, Ani Fatmawati, Samen Lolongan, Hidayat Hidayat

Abstract: Log Harvesting technology using a monocable winch machine was proved to have reduced the production costs and reduced environmental damages compared withthe use of a bulldozer, and contributes to the fact of being harder to get the natural-forest woods confronted by longer routes and tougher topographical rain forest through swampy areas to get bigger logs nowadays. To skid a bigger diameter or volume of logs requires a much a bigger machine. The main purpose of this research was to find out about the influence of engine capacity improvement from 20HP to 26 HP upon log harvest skidding. Application in log skidding using the 20HP engine generated 7,08 m^3/h-1hm productivity, while that of the 26HP generated a 8,52 m^3/h-1hm productivity. This shows that the productivity improvement from the 20HP to 26HP engines was 20,33%. However, thet-test, shows that the engine improvement from 20HP to 26HP in terms of log skidding productivity at PT Ratah Timber incorporated did have a significant effect.

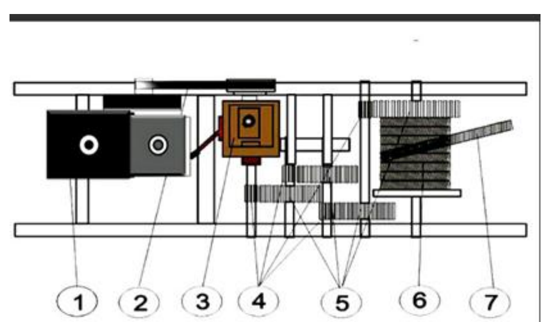
Index Terms: East Borneo, skidding machine, engine capacity, Kalimantan Timur, bulldozer, log harvesting.

1 INTRODUCTION

One of the skidding equipment locally used in East Borneo since 2000s has been amonocable winch known locally recognized as the skidding machine, which has been applied legally at a few logging operations at their natural forest or industrial forest concessions and it has even been used to skid logs at swampy areas. This machine has been mostly produced at Samarinda and has been used quite a lot on sites by the local community due to its low-cost investment, easy operation, easily available spare parts as well as being mobile to transport and easy to maintain. This machine has even been planned to be exported to Liberia to perform environmentally-friendly logging operations. This machine was originally used as a piling machine to construct buildings, bridge and to pull ships aside at the harbor. In its application, this machine consists of a few gears, which ispowered up by a diesel engine (Dong Feng, Inda and Yanmar diesel-engine brands). To be able to operate, a few more gears (6–8 pieces) had been added to generate more powerful capacity in skidding logs. The modification also made use of truck axle drives that is transmitted by this diesel engine.

- *Ruspita Sihombing is a Lecturer of Mechanical Engineering Department in Politeknik Negeri Samarinda, Indonesia. Email: ruspita.sihombing@yahoo. co.id*
- *Martin Surya Putra is a Lecturer of Mechanical Engineering Department in Politeknik Negeri Samarinda, Indonesia. Email: mrtputra@yahoo.com*
- *Ani Fatmawati is a Lecturer of Mechanical Engineering Department in Politeknik Negeri Samarinda, Indonesia. Email: anni140763@gmail.com*
- *Samen Lolongan is a Lecturer of Mechanical Engineering Department in Politeknik Negeri Samarinda, Indonesia. Email: sam_lolongan@yahoo. co.id*
- *Hidayat Hidayat is a Lecturer of Mechanical Engineering Department in Politeknik Negeri Samarinda, Indonesia. E-mail: hidayat@polnes.ac.id*

To skid logs at the forests, this machine has been designed to stand up for more than 4 meters high to ease the skidding performance. The machine specification observed in this research consists of the Dong Feng-trade mark engines with 20HP and 26HP capacities, completed with six gears functioning to transmit power to the other driving gears and ¾ inch sling. The fuel used was the diesel fuel. A set of equipment consisting of machinery, Dong Feng diesel engine and a 100-meter wire sling totally cost IDR 40 million (2010-IDR price). According to Hertianti [9], the machine of this kind used in this research is shown in the following profile.



1 = dong feng
2 = van belt
3 = gear box
4 = drive gear
5 = driven gear
6 = drum roll
7 = slink

***Figure 1.** Monocable winch Skidding Machine (Hertianti 2005).*

The use of winching machine has been implemented by PT Belayan River Timber since its 2009/2010 logging operation. This company has been using 10 units of winch machine. In its application, PT Belayan River Timber has applied the principles of 'Reduced Impact Logging' i.e. in topography, log mapping, skid-line planning, skid-like marking, directional felling and winching. By applying the operating procedures in harvesting, it is expected that sustainable forest management can be achieved. The purpose of this research was to find out about how the winching machine works, the winching timeline efficiency and the winching productivity. In Global Sanyoto [19], in global divides the work timeline into two parts.

1. GenericTimeline Worked

Generic Timeline Worked is the hours required to conduct actions that have no direct effect upon purely productive work, but it is required to keep the work run smoothly. This generic time is divided into silent time, avoidable lost time, unavoidable lost time, break time and personal time.

2. Purely Productive Timeline Worked

Purely productive work is the hours required to conduct primary work, being classified productive. Purely productive Timeline Worked is the hours required to conduct primary working hours, classified productive work. It consists of engine start-up preparation, log line land clearing, sharpening the log edges, winching, installing, connecting the slings, winching the logs, regulating, releasing and rewinding the slings.

Winching productivity was worked out using the Brown [2] formula:

$$P = (V)/(Wa + Wo + Wb) \; [1/\text{ hour}] \qquad (1)$$

Remarks:

- P = Winching productivity (m^3/hour)
- V = volume of logs winched per trip (m^3/trip-1)
- Wa = preparation and installation time for equipment (hour)
- Wo = operation time (hour)
- Wb = winching and excavation of equipment (hour)

What was expected from the research was to provide information on the procedures and productivity improvement in winching the logs using the winching machine from 20HP to 26HP.

2 EXPERIMENTAL

Research was conducted at Ratah Timber Company (RTC) located at 1140 55' - 1150 30' East longitude and 002'LS- 00 15 ' North latitude falling into Long Hubung and Laham sub-districts of East Kalimantan Province at MamahaqTeboq site of the Upper Mahakam District of East Kalimantan. Inclination of this area is ± 71,9 % classified plain. Types of soil consist of reddish yellowish podsolic, latosol and alluvial. Research nature was analytical, literature-oriented and field measurements. The data used in this research were primary and secondary ones. The primary data were obtained from preparation activitiess consisting of field orientation, selection of pilot sites from middle to highly hilly terrains.

1. Technial Aspects

To obtain the timeline worked, a non-stop method (involving equipment preparation, access land clearing for logs, placement of winch machine on log piles, sling retraction towards the logs, placement of slings to the winched logs using hooks, logs retraction, hook releases, log arrangement and sling rolling). Generic time line consisting of machine disturbances, cut-off slings, left tools, steadiness (drinking, smoking, chatting, breaking), fuel refilling, radiator refilling, cutting (log clearing) were also taken into account. In addition, measurements against the winching distances, diameters from the center to the edge of logs winched. The other supporting data were the winch machine specifications. Secondary data were those collected from literatures, electronic media sources, previous research or the company's available reports.

2. Social Aspects

Social aspects consist of general descriptions of the men power's area of origin through field survey in which they were interviewed and in which reports on the winch machine operations were taken for analysis at the company.

3 RESULTS AND DISCUSSION

1. Technical Aspects

Comparison among the Total of Pure Timeline Worked, Generic Timeline and Timeline Worked by the 20 HP and 26 HP engine on a Slope ≤ 40% (Plain to Steep) Based on the results of the pure timeline and generic timeline worked at the plot area using the 20HP engine in winching 89 pieces of logs and that using the 26HP engine in winching 67 pieces of logs, the average timeline worked obtained was tabulated in the following table. The following table describes the average pure timeline worked, generic timeline and timeline worked on a slop ≤ 40%, as shown on a graph.

TABEL 1. *AVERAGE PURE TIMELINE WORKED, GENERIC AND TIMELINE WORKED ON SLOPE < 40% (PLAIN-STEEP CONTOUR) 20 HP AND 26 HP ENGINES*

Work Timeline	20 HP [hour]	26 HP [hour]
Total of pure hours worked	0.74	0.67
Total of generic hours worked	0.07	0.09
Total of average hours worked	0.81	0.76

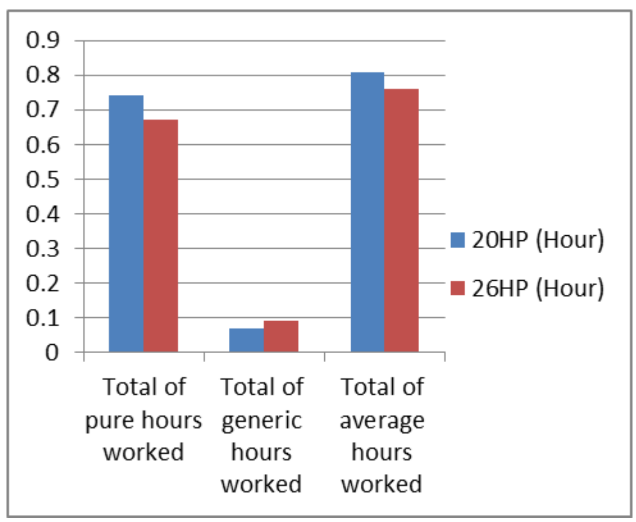


Figure 2. *Graph on the Total of the average pure timeline Worked, Generic Timeline and Timeline Worked of the 20HP and 26HP machine on a slope ≤40% (plain to steep Contour)*

Based on figure 2, it was revealed that the 20HP engine capacity timeline worked was bigger than that of the 26HP, due to the fact that on the same winching distances, the engines produced the same rotation. In other words, the speed was the same, but the tensile strengths on both engines were different, making the bigger 26HP engine produced a bigger capacity to winch bigger-log masses. In addition, the log standing on the pilot area using the 20HP engine was bigger and that of the 26HP. This means that the timeline worked using the 20HP engine was bigger than that of the 26HP. In general, however the 26HP engine capacity was bigger than the generic timeline worked of the 20HP machine.

Testing the Difference between the Average Timeline Worked in Winching Logs Using the 20HP and 26HP Engines on a Slope +≤ 40% (Plain-Steep)

To test whether there was a difference between the average timeline worked for the logs productivity using the 20HP and 26Hp engines, the t-test or the Independent Samples of the t-test was used as shown in the following table.

TABLE3

RESULTS OF THE HOMOGENEITY TEST AND THE INDEPENDENT SAMPLE T-TEST OF 20HP AND 26HP ENGINES

		Homogenity test		t-test for average equatation			
		f	sig	t	df	95% crediability interval	
						Low test	Hgh test
Productivity	Variant equation assumed	0.58	0.45	1.88	154	2.94	0.07
	Varian equation not assumed			1.88	141	2.95	0.07

Result of the Levene's (homogeneity) test shows that the F-value was 3,84with a significance of 0,052, where 0,052>0,05,meaning that H0 was accepted. Conclusively the variant data of the timeline worked using 20HP engine and 26HP engine on a slope ≤40% have the same variants. From the independent sample t-test, it was found out that the t-computed was 0.67. the t-table on two-side significance (0.05: 2) with the degree of freedom 154 was 1.98. As the t-computed was smaller than the t-table, h0 was accepted, meaning that there was not a significant difference between the timeline worked using the 20HP and 26HP engines on a slope ≤ 40%.

Logs Winched Productivity

Using the following Brown (1958) formula,

$$P_{total} = \frac{\sum_{i=1}^{n} V_i}{W_a + W_o + W_b} \qquad (2)$$

the logs winched productivity using the 20HP engine was worked out to be averegely 7,08 m3hour-1hm (enclosed), while that of 26HP was averagely 8,52 m3.hour-1hm) (enclosed) Results of computation shows that the productivity using the 20HP engine in contrast with that of 26HP wereas follows.

$$\%\ Productivity\ \ Raise = \frac{8.52 - 7.08}{7.08} \times 100\ \%$$

= 20.33%

Testing the Engine Capacity Differences for the Average Logs Winched Productivity To test whether there was a difference in the average productivity of the log winched using the 20HP and 26HP engines, the t-test or the independent sample t-test was used as shown on the following table.

TABLE 4

RESULTS OF HOMOGENEITY TEST AND THE INDEPENDENT SAMPLE T-TEST FOR THE 20HP AND 26HP ENGINES FOR THE AVERAGE PRODUCTIVITY OF LOGS WINCHED ON A SLOPE ≤ 40%

		Homogenity test		t-test for average equatation			
		f	sig	t	df	95% crediability interval	
						Low test	Hgh test
Productivity	Variant equation assumed	0.58	0.45	1.88	154	2.94	0.07
	Varian equation not assumed			1.88	141	2.95	0.07

The independent t–test sample shows that the t-computed was -1,88. The t-table on the two side significance (0,05 : 2) under the degree of freedom 154 was 1,98. Because t-computed was bigger than that of the t-table (t-computed>t-table), it means that H_0 was accepted that there was not a significant difference between the logs winched productivity using the 20HP and 26Hp engines on a slop ≤ 40% . This was because the log masses winched using the 20HP and 26HP engines had not influenced the strength of tensile generated by the 20HP engine. In other words, if the 20Hp engine was assumed to be safe with such strength of tensile, the 26HP one was even safer which, in turn, lead to insignificant difference of productivity between the two engines. Except if the log masseswinched on the pilot area using the 20HP and 26HP engines had been under or over the strength of tensile generated by each of the engines when winching bigger log masses using the 20HP engine, they would have exceeded the strength of tensile generated or have produced smaller capacity than that of the 26HP one. As a consequence then, the logs could not have been winchedwithout using the 26HP engine. Therefore, it was definite that there was a difference of productivity in winching logs using the 20HP and 26HP engines. In this research, the actual output of statistical computation shows that the 20HP productivity had increased by 20.33%, meaning that the increase was quite significant. In other words, it could not be solely judged by the t-test. Results of the t-test show that there was not a significant difference of productivity using the 20HP and 26HP engines.

2. Social Aspects

The winching machine is technologically simple, which does not require specific-skilled men power as those who operate bulldozers. The local community has been accustomed to using this winch machine that they can easily employed by the logging company legally. This has a positive impact towards the local community's welfare living around the forest where such a machine is being practiced. Locally legal men-power recruitmentat the logging concession site will help reduce illegal logging practices done by the local community. The winch machine requires 1 team consisting of 5 people, i.e. a chainsaw operator, helpers, a winch machine operator and a hook-man.

4 CONCLUSION

The 20HP engine productivity produced 7.08 m^3/hour hm, while that of the 26Hp produced 8,52 m^3/hour hm. This indicates that the productivity had increased by 20.33% using the 20HP to 26Hp engines. Results of the t-test indicates that the influence of engine capacity raise from the 20HP to the 26HP for the logs winched productivity at PT Ratah Timber was insignificant.

REFERENCES

[1] Bertault JG, Sist P. 1997. An experimental comparison of different harvesting intensities with reduced-impact and conventional logging in East Kalimantan, Indonesia. Forest EcolManag 94: 209-218.

[2] Brown NC. 1958. Logging The Principles and Methods of Timber Harvesting in the United States and Canada.New York: John Wiley & Sons Inc.

[3] Edwards DP, Tobias JA, Shei l D, Meijaard E, Laurance WF. 2014. Maintainin ecosystem function and services in logged tropical forests. Trends EcolEvol 29:511-520.

[4] Elias. 2002. Book 1 Reduced Impact Logging. Bogor: IPB Press.

[5] Escobar FV, García GAR. 2013. Small and simple technology cable system for logging, Medellín, Colombia.

[6] FAO. 2010. Global forest resources assessment 2010. Progress towards sustainable forest management. FAO Forest Paper 163. Food and Agricultural Organization of the United Nations, Rome, Italy.

[7] Fredericksen TS, Pariona W. 2002. Effect of skidder disturbance on commercial tree regeneration in logging gaps in a Bolivian tropical forest. Forest EcolManag 171:223-230.

[8] Healey JR, Price C, Tay J. 2000. The cost of carbon retention by reduced impact logging. Forest EcolManag 139, 237-255.

[9] Hertianti E. 2005. A Study on log Skidding with the Monocable System at Sungai Linuq Compound, Tabang Sub-District, KutaiKartanegara District, Post Graduate Thesis. Samarinda: Post Graduate Study, MulawarmanUniversit

[10] John JS, Barreto P, Uhl C. 1996. Logging damage during planned and unplanned logging operations in the eastern Amazone. Forest EcolManag 89:59-77

[11] Liah Y. 2012. Comparison of impact skidding with mono-cable winch with bulldozer to damage of residual stand. [Thesis]. Mulawarman University, Samarinda. [Indonesian].

[12] Meijaard E, Sheil D, Nasi R, Augeri D, Rosenbaum B, Iskandar D, Setyawati T, Lammertink MJ, Rachmatika I, Wong A, Soehartono T, Stanley S, O'Brien T. 2005. Life after logging: reconciling wildlife conservation and production forestry in Indonesian Borneo. CIFOR, WCS and UNESCO, Bogor, Indonesia.

[13] Muhdi. 2008. The impact of timber harvesting with reduced impact logging systems to the soil compaction in West Kalimantan. Kalimantan For J 13(1): 42-45.

[14] Pinard MA, Putz FE. 1996. Retaining forest biomass by reducing logging damage. Biotropica 28:278-295.

[15] Pinard MA, Barker MG, Tay J. 2000a. Soil disturbance and post-logging forest recovery on bulldozer paths in Sabah, Malaysia. Forest EcolManag 130:213-225.

[16] Pinard MA, Putz FE, Tay J. 2000b. Lessons learned from the implementation of reduced impact logging in hilly terrain in Sabah, Malaysia. Intl Forest Rev 2(1): 33-39.

[17] Ruslim Y, Hinrichs A, Sulistioadi B. 2000. Study on implementation ofMreduced impact tractor logging. SFMP Document No. 01a.

[18] Ruslim Y. 2011. Implementing reduced impact logging with mono-cable winch. J Trop ForManag XVII (3): 103-110.

[19] Sanyoto. 1976. Analysis on Work Timeline, A Thesis: Bogor: Institute of Agriculture.

[20] Sari, D.R. 2013. Study on Productivity and Skidding Cost Analysis under the Monocable Machine at Belayan Timber Logging Concession, Laham Sub-District, Kutai Barat Disrict, an Unpublished Thesis, Samarinda: Mulawarman University.