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Engine Raise Capacity in Terms of Costing Element of Log Skidding Using a Monocable Winch at PT Ratah Timber

Ruspita Sihombing[1] Yosep Ruslim[2]
1.Polytecnich Negeri Samarinda, Indonesia
2.Faculty of Forestry, University of Mulawarman Samarinda, Indonesia

Abstract
Log skidding using a monocable winch is less costly compared to that using a bulldozer (Ruslim, et al., 2011). Study on engine capacity raise on costing elements of log skidding using this monocable winch was aimed at finding out about: (1) Economical aspects, how much the skidding costs involved using this winch. This study was focused on raising the engine capacity from 20-HP to 26-HP. Research method used was a combination of quantitative and qualitative taking into account factors of (1) Dimension (diameters of center, edge and length) of the stems to find out about the stem volume skidded; (2) the time taken in skidding, i.e. finding about the phenomenon of pure and general timeline required; and (3) total and price of equipment, fuel, oil and grease spent.Results of the research indicate that raising the engine capacity in skidding using the 20-HP engine was higher than that of the 26-HP in terms of skidding cost, which was Rp 12.364,83 $m^{-3}hm^{-1}$ > Rp 10.853,05 $m^{-3}hm^{-1}$. In other words, raising the engine capacity from 20-HP to 26-Hp managed to reduce the skidding cost on 1 hm distance down to Rp 1.511,78 m^{-3}
Keywords: Skidding, Productivity and Operating costs

I. INTRODUCTION

In general log skidding in logging operation most companies in East Kalimantan is of ground-based bulldozer skidding. The application of this heavy equipment as the only skidding equipment has been well-known, despite the efforts to reduce the environmental impacts (soil and forest uncovering). While a thought to a more reduced impact logging using bulldozers has not been able to reach maximal outputs, particularly on those with middle to heavy topographical contours due to the restricted mobility of bulldozers. The idea of using another alternative skidding equipment exceeding the bulldozer's capability then, became apparent. Another reason, was, or course, the constantly increasing cost of fossil fuel impacting on more costly production cost using bulldozers than that using monocable winches with more effective log skidding coverage in addition to the fact of engaging the local community to be legally employed in their companies by helping keep their own productive natural forest everlasting that such considerations were worth experimenting. (Ruslim, 2011).

Log harvesting, so far, has been conducted in a conventional way with unwell-plan, bad implementation procedures and weak supervision of the authorities resulting in the forest environmental destruction. (Elias 1997; Dykstra, D.P. and R. Heinrich, 1996, Ruslim et al. 2000). This destruction has also been generated by non-environmentally-friendly equipment such as the use of bulldozers on forests with unstable soil condition where the use of such equipment has been inappropriate.

Reduced Impact Timber Harvesting/RITH has become a significant indicator in everlasting forest management. Study by Pinard et.al., 1995; Sularso, 1996; Elias, 1998 show that low-impacted forest harvesting method has been able to reduce the natural production forest's ecosystem destruction..

One of the most environmentally-friendly log skidding equipment is monocable winch, that works by being stationed on a particular point, while logs are being skidded using wire ropes or cables. Study by Erina Hertianti et al; 2005 shows that this equipment requires small-scale investment, less land clearing and is of multi-purposed function

Previous study on a monocable winch using the 20-HP engine can skid 8 tons of logs, causing less environmental impacts in terms of soil uncovering and its surrounding tree stands. Less contamination impacts were related to less fuel consumption resulting in the reduced carbon emission produced by fossil fuel, in addition to less costly operation and engagement of the local community involvement. (Ruslim, et al., 2011).

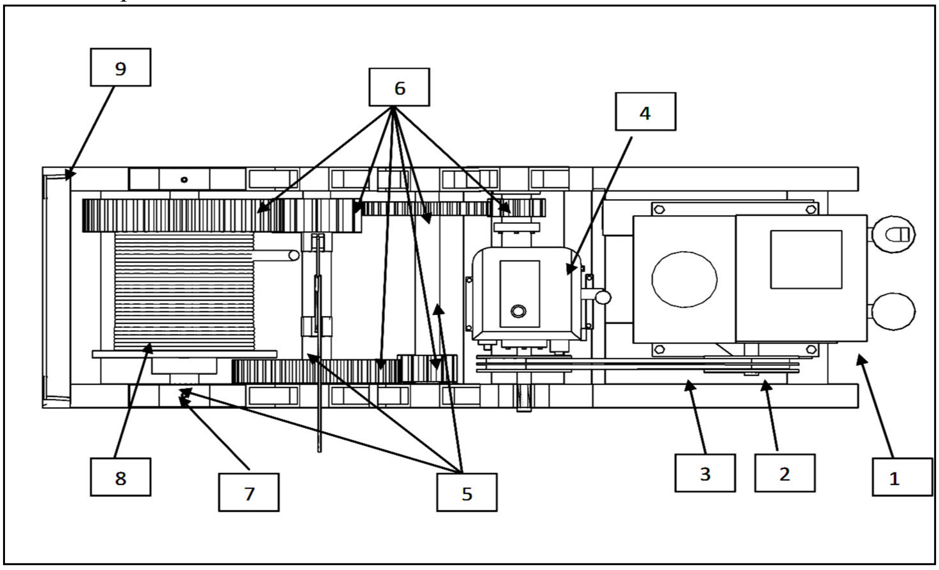
The use of monocable winches has been implemented by PT Belayan River Timber since its 2009/2010 logging operation. This company has applied 10 units of equipment starting from topographical surveys, log mapping, skid line planning, skid line marking, directed felling and winching. With such applications in their harvesting, everlasting sustainable forest management can be achieved (Ruslim, et al., 2011 cited in Sist et al. 2007).

Monocable winch has been well-known to the East Kalimantan's local community to be used to skid logs in their natural forest habitat and been used in industrial forest plantation, and has even been used in swampy forest log skidding. The use of such equipment has been quite expansive in swampy forest log skidding operation. The expansive use of this equipment by the community is due to its cheap investment cost, easy operration on site, easy transportation and maintenance.

The Reduced Impact Logging (RIL) method implemented at PT Ratah Timber Company using the 20-HP and 26-HP engines in this study was upon initiation of Sihombing et all. (2015).

To what extent the operation cost involved in skidding operation was the aim of this study by raising the engine capacity. Results gained from this study were expected to be able to provide information on determining the most suitable engine capacity on forest areas to comply with the available diameters of log stems of the concerned forest.

A. General Description of the Monocable Winch Machine



Gambar 1 . Skema Monocable Winch Machine

Remarks:

1. Engine
2. Pulley
3. V-Belt
4. Gear Box (transmission)
5. Shaft
6. Gears
7. Roller bearings roll
8. Wire rope Cable
9. Chasis

II. RESEARCH METHOD

A. RESEARCH LOCATION, TIMELINE

Research on log skidding using a monocable winch was implemented in November 2013 at PT. Ratah Timber Company (RTC) located at 114^0 55’ - 115^0 30’ East longitude dan $0^{02'}$LS - 0^0 15 ‘latitude within the range of Long Hubung and Laham subdistricts, Mahakam Hulu District, East Kalimantan. Type of soil at the Mamahaq Teboq village of this newly established Mahakam Hulu District was classified red yellowish podsolic, latosol and alluvial with an inclination of the operation area of - /+ 71,9 % classified flat to sloping contour. Types of climate, according to **Schidmat** and **Fergusson (1993),** at the operation area of PT RATAH TIMBER COMPANY was classified very high or type A with 12 months of wet months (Q value = %).

The data used in this research consist of primary and secondary ones, the primary data were obtained from preparation stage of site orientation activities and plot selection under which the 20-HP and 26-Hp engine were experimented.

B. RESEARCH MATERIALS AND TOOLS

Materials; Wood

Supporting equipment, among others are:

1. Monocable Winch completed with 20-HP and 26-HP engines
2. Stopwatch, to measure time of each skidding work element
3. Compass, to make research plots
4. Clinometer, to measure site inclinations.
5. Meters, to measure diameters, lengths and distance of logs skidded.
6. Crayon or paints, to mark the logs measured.
7. Camera for documentation
8. Stationary

C. RESEARCH PROCEDURES

1. Preparation

Activities conducted covered:

a. Site Orientation
b. Plot selection on middle to sloping contours

2. Data Collection
   a. Direct site observation to obtain primary data:
   - Recording logs a series of skidding activities using monocable winch
   - Measuing inclinations of each skid line during the on-going skidding process.
   - Measuring the work timeline using the non-stop method (preparation of equipment, cleareance of Logs paths, monocable winch bound to the tree trunk or standing tree, wire rope directed to logs, wire rope bound to logs to be skidded using hooks, logs skidding, hook releases, logs stacking and wire rope winching).
   - Measuring skid distance.
   - Measurement of length and diameter of center and edge of logs skidded
   - Measuring length of sharpening.

   b. Indirect observation to get the supported data.
   - Log dispersion mapping and contour map.
   - Skidding equipment specification using monocable winch.
   - Price of equipment, fuel, oil and grease.
   - Other data concerning the research.

D. DATA PROCESSING

1.Skidding Productivity

To get the work timeline, a non-stop method (work elements covering preparation of equipment, making path clearance for logs, binding monocable winch to the tree trunk or standing tee, pulling wire rope to the logs skidded using hooks, skidding the logs, hook releases, logs stacking and winching the wire rope). Apart from these, measurement of skid distance, length and diameter of log center and edge were also measured. The other supporting data were the tree dispersion mapping, prices of equipment, fuel, oil and grease and other data concerning the research.

Skidding productivity was calculated using the Brown (1958) formula:

$$P = V/W$$

Where:
P = Skidding productivity (m^3 $hour^{-1}$)
V = volume skidded per trip (m^3 $trip^{-1}$)
W = Time of operation (hour)

Log Volume skidded was calculated using the following formula:

$$V = {}^{1}/_{4}\, \pi\, d^2 \times p$$

Where :
V = Volume of logs skidded (m^3)
$\bar{d}$ = Diameter (cm)
P = Length of stem (cm)
π = 3,14

Skidding productivity on 1 hm skid distance was calculated using the following formula:

$$P_s = (V/W) \times S$$

Where:
P_s = Skidding productivity on 1 hm skid distrance (m^3 $hour^{-1}$ hm)
S = Skid distance (hm)

2.Skidding Costs

a. Fixed costs

1. Depreciation

Depreciation was calculated using the straight line cepreciation method (Newman, 1988).

$$D = \frac{M - R}{N}$$

2. Interest, taxes and insurance were calculated using the average investment interest formula (Prasmono, D. 2011 cited in Wiradinata, 1981):
   Taxes on interest, Insurance $B = (M\text{-}R) \times (0.0\ p/2) \times (n + 1)/n$.

3. Repair and maintenance costs = $\frac{M \times 0,01}{1000}$

Remarks: D = Annual Depreciation (Rp/ annum)
M = Price of a tractor purchase (Rp)

R = Price of wracked tractor (Rp)
n = Number of hours in use (hour)
N = Length of tractor use (annually)
0,0p = Interest, taxes and insurance (percent/ annum)

b. Unfixed costs consist of:

b.1. Operation costs

1. Fuel, oil and grease = average use per hour x purchase price per liter (Rp/ hour)
2. Wire rope = Average use per hour x Purchase price per unit (Rp/ hour)
3. Fee for operator and his assistant based on output produced (contracted work) (Rp/m³ hm)

b.2. Fees

1. Cost of equipment mobilization is the average use per hour x purchase price per unit (Rp/ hour).
2. Cost of personnel consumption and personnel use was the average per hour x purchase price per unit (Rp/ hour)

c. Total cost (Machine business cost)

$$TC = FC + VC$$

Remarks:
TC = Total Cost (Fixed total)
FC = Fixed Cost (Fixed Cost)
VC = Variable Cost (Variable Cost)

d. Cost of production unit output = $\frac{\text{Machine business cost}}{\text{Productivity}}$ (Rp/m^3 hm)

e. Cost of skidding operation = cost of production unit output + operator and his assistant fees.

III. RESULTS AND DISCUSSION

Result of calculation was based on the 2012 cost reference (Sihombing et al, 2015), showing that to produce 1 m^3 logs with a skid distance of 1 hm on an inclination < 40 % requires the following costs:

1. Machine business cost as seen on table 1

***Table* 1**. Skidding costs using the 20-HP and 26-HP monocable winches.

No	Cost Component	Total	
		20 HP	26 HP
1	Fix Cost		
a	*Depreciation*	Rp. 3.850,-/hour	Rp. 4.800,-/hour
b	Interest, taxes and insurance	Rp. 14.760,-/hour	Rp. 15.600,-/hour
	Fixed costs (a + b)/ *Fix Cost* (*a*+ *b*)	Rp. 18.610,-/hour	Rp. 20.400,-/hour
2	V*ariable Costs*		
a	Diesel 5 (20 HP);6, 5 (26 HP) liter/day @ Rp.14.000,-/liter = Rp. 91.000,-/8 hours	Rp. 8.750,-/hour	Rp. 11.375,-/hour
b	Oil 13 liters/bulan @ Rp. 34.000,- = Rp. 442.000,-/200 hours	Rp. 1.700,-/hour	Rp. 2.210,-/hour
c	*Wire rope* 100 m/3 bulan @ Rp. 5.000.000,- = Rp. 5.000.000,-/(3 x 200 hour)	Rp. 8.333,-/hour	Rp. 8.333,-/hour
d	Consumption Cost/ Personal cost per team = Rp. 9.000.000,-/200 hours	Rp. 45.000,-/hour	Rp. 45.000,-/hour
c	*Transportation cost* Rp. 1.500.000/5 years (2000 hours)	Rp. 150,-/hour	Rp. 150,-/hour
e	Repair /*Maintenance Cost* = Rp. 1.000.000,-/200 hours	Rp. 5.000,-/hour	Rp. 5.000,-/hour
	Total of Variable Cost	Rp. 68.933,-/hour	Rp. 72.068,-/hour
	Grand Total of Cost	Rp. 87.543,-/hour	Rp. 92.468,-/hour

2. Production Unit Output Cost (Skidding cost per m^3)

A study by Sihombing et al, 2015 shows that the 20-Hp engine monocable winch produced 7,08 m^3/ hour.hm productivity, while the 26-HP produced 8,52 m^3/hour.hm productivity that the following skidding costs per m^3 was obtained

a. 20-HP engine Rp 12364,83/m^3hm (skidding cost per m^3 at 1 hm skid distance was Rp 12.364,83/ m^3hm).

b. 26-HP engine Rp 10.853,05 m^{-3}hm (skidding cost per per m^3 at 1 hm skid distance was Rp. 10.853,05 m^{-3}hm).

If the fees received by the monocable winch team are Rp110.000/ m^3 with Rp20.000 for the owner and Rp 90.000 for the work team, it means that the average members of the monocable winch team plus their felling cost totally equal to the cost of people with Rp15.000/m^3hm (Sihombing et al, 2015) .

The skidding operation costs per $m^{3\ at}$ at 1 hm skid distance are

1. The 20-HP engine costs Rp. 27364,83/m^3hm
2. The 26-HP engine costs Rp 25.853,05/m^3hm

When compared with the skidding cost per m^3 at 1 hm skid distance between the 20-HP and the 26-Hp engines, it was apparent that the operating cost using the 20-HP engine was higher than that of the 26-Hp. (Rp 27.364,83/m^3hm>Rp 25.853,05/m^3hm). This was due to 0the engine productivity raise from 20 to 26 for 20,33% (Sihombing et al, 2015). This raise, however, was not significant due to the average stem diameters, which were found smaller at the research plot that they just required the 20-HP engine capacity. The 26-HP engine, then was not used to its maximal strength of tensile (Sihombing et al, 2015). A difference in skidding costs per m^3 at 1 hm skid distance was Rp 1.511,779/m^3hm.

CONCLUSIONS

1. The engine capacity raise caused higher machine business cost
2. A raise in the engine capacity resulted in a smaller cost of skidding production output unit
3. A raise in the engine capacity resulted in a much smaller skidding operation cost
4. A raise in the engine capacity resulted in the decreased operating cost down to Rp. 1.511,78/m^3hm.

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