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PRODUCTIVITY AND COST ANALYSIS OF FELLING AND BUCKING OF TEAK TREES (*Tectona grandis* L.F.) USING REDUCED IMPACT LOGGING (RIL) TECHNIQUE IN TELAWA FOREST MANAGEMENT UNIT, CENTRAL JAVA

(Produktivitas Dan Analisis Biaya Penebangan Serta Pembagian Batang Tegakan Jati (Tectona grandis L.F.) di RPH Ngaren, BKPH Kedungcumpleng, KPH Telawa)

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ABSTRAK

Kegiatan pemanenan merupakan salah satu bentuk kegiatan pengelolaan hutan yang bertujuan untuk meningkatkan nilai hutan, mendapatkan produk hasil hutan yang dibutuhkan masyarakat, serta memberi kesempatan kerja bagi masyarakat di sekitar hutan. Salah satu hasil hutan di Pulau Jawa yang banyak dimanfaatkan karena kelebihannya adalah kayu jati (Tectona grandis L.f.). Salah satu KPH yang memproduksi kayu jati adalah KPH Telawa Perum Perhutani. Penerapan teknik RIL diharapkan dapat meningkatkan produktivitas dan memperoleh hasil yang optimal, serta wewujudkan pengelolaan hutan lestari. Penelitian ini bertujuan untuk menghitung produktivitas dan biaya yang diperlukan pada kegiatan penebangan dan pemotongan. Pengambilan sampel dilakukan dengan metode purposive sampling dengan kriteria tegakan jati pada kelas umur yang sama di RPH Ngaren, BKPH Kedungcumpleng, KPH Telawa. Data diperoleh melalui pengukuran 36 sampel tegakan jati homogen pada kelas umur V dan kelas diameter yang sama. Pengukuran waktu kerja menggunakan metode kumulatif. Hasil penelitian menunjukkan produktivitas efektif tebangan dan pembagian batang di RPH Ngaren sebesar 1,80 m^3/jam. Hasil analisis regresi menunjukkan bahwa volume dan waktu efektif mempunyai pengaruh yang signifikan terhadap produktivitas tebangan dan tebangan. Volume berbanding lurus dengan produktivitas, sedangkan waktu kerja berbanding terbalik dengan produktivitas. Analisis biaya meliputi biaya tetap dan biaya variabel sehingga diperoleh hasil sebesar Rp34.120,08/m^3.

Kata Kunci: jati, pemanenan hutan, produktivitas, RIL

ABSTRACT

Forest harvesting activities are forest management activity which aims to increase forest value, obtain forest products needed by the community, and provide employment opportunities for communities around the forest. One of the forest products in Java Island that is widely used because of its advantages is teak wood (*Tectona grandis* L.f.). One of the KPHs that produces teak wood is KPH Telawa Perum Perhutani. The implementation of Reduced Impact Logging (RIL) techniques is expected to increase productivity and obtain optimal results, as well as realizing sustainable forest management. This research aims to calculate the productivity and costs required for felling and bucking activities. Sampling was carried out using a purposive sampling method with the criteria of teak stands in the same age class at RPH Ngaren, BKPH Kedungcumleng, KPH Telawa. Data was obtained by measuring 36 samples of homogeneous teak stands in age class V and the same diameter class. Measuring working time uses the cumulative method. The research results show that the effective productivity of cutting and dividing stems in the Ngaren RPH is 1. 80 m^3/hour. The results of the regression analysis show that volume and effective time have a significant

influence on felling and felling productivity. Volume is directly proportional to productivity while working time is inversely proportional to productivity. Cost analysis includes fixed and variable costs to obtain IDR 34,120.08/m^3 results.

Keywords: teak, forest harvesting, productivity, Reduced Impact Logging,

I. INTRODUCTION

Forest harvesting activities are forest management activities that aim to increase forest value, obtain forest products needed by the community, and provide employment opportunities for communities around the forest. Forest harvesting is a series of forestry activities that convert trees and other biomass into a form that can be moved to other locations to benefits the community's economic and cultural life (Elias, 2024). One of the timber forest products in Java that has been utilized is teak wood. Teak forest in Java Island is mostly managed by Forest Management Unit (FMUs) which are part of the forest management area within the Perum Perhutani's work unit. One of the FMUs that produces teak in Indonesia is KPH Telawa and is included in the working area of Unit I of the Central Java Regional Division.

The high demand for teak wood in the makes Perhutani, one of the main producers of teak wood in Indonesia, must be able to increase their production. One of the efforts to increase teak wood production is to optimize the harvesting process, especially in the early stages, namely felling and bucking (Prakosa, 2022). Felling and bucking must be accurate to obtain the sortimens needed by the market (Gautama et al., 2019). In line with these efforts, the basic information from good planning, monitoring, and evaluation activity is productivity (Assegaf et al., 2023).

Currently, felling and bucking activity of teak stands in KPH Telawa has implemented the Reduced Impact Logging (RIL) technique. RIL is commonly known as environmentally friendly harvesting which aims to reduce damage to live stands, by reducing the impact of harvesting on the environment so that it remains in good condition in the next harvesting cycle (Elias, 2024). The application of RIL techniques is expected to provide maximum benefits through increased productivity (Suhartana & Yuniawati, 2017). One of the RIL techniques that has been carried out at KPH Telawa is implemented in the creation of backcut mats, which is carried out with the aim of optimizing felling volume, reducing waste and reducing damage to remaining stands. On the other hand, conventional logging techniques do not plan and without considering damage to remaining stands.

Productivity is closely related to harvesting costs, the greater the productivity, the lower the harvesting costs are, and vice versa (Jenaro et al., 2018). This study aims to determine the productivity and costs required in felling and bucking activities at RPH Ngaren, BKPH Kedungcumpleng, KPH Telawa. This research is expected to be an overview of information for KPH Telawa to improve company performance and is expected to become a reference for further research.

II. METHODS

This research was conducted in Plot 204-D, RPH Ngaren, BKPH Kedungcumpleng, KPH Telawa (Fig.1), with teak plant types planted in 1998. The tools used in this research are tally sheet, stopwatch, meter, phi band, teak wood volume table SNI 7535.3:2016, phone camera and laptops, equipped with SPSS software, Ms. Excel, and Ms. Word.

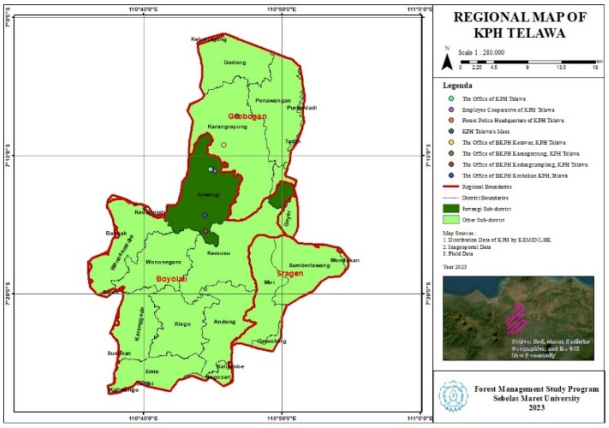

Figure 1. Location Map of KPH Telawa
Gambar 1. Peta Lokasi KPH Telawa

The sampling method used was purposive sampling. Data was obtained by measuring 36 samples of homogeneous teak stands in age class V and the same diameter class. The criteria for teak stands in this study were homogeneous teak stands with Age Class V (KU V) with a planting year of 1998 and the same diameter class, namely 20-29 cm. Working time was measured using the cumulative method, which is to let the stopwatch needle to run continuously without returning to zero at the end of each element (Bora & Kamariah, 2020). The time for each element is obtained by subtracting sequential work elements. Time measurements were carried out directly at the place where work was in progress by video recording the felling and stem distribution activities. Time measurements were carried out at every cycle of cutting and dividing the stems. The work elements involved in felling and dividing the trunk start from the chainsaw operator turning on the machine to the activity of dividing the trunk from the base to the tip. Data analysis was carried out by calculating sorting volume and work productivity.

Work productivity was calculated using the Conway formula (1976):

$$P = \frac{V}{W}$$

Description:
P = productivity (m3/hour)
V = volume of wood harvested (m3)
W = average working time (hour)

Based on the Indonesian National Standard (SNI) 8911:2020, concerning Measurement and Determination of Round Wood Content, the volume of teak wood is calculated using the Brereton formula for fallen trees:

$$V = {}^{1}/_{4}\,\pi \left(\frac{Du+Dp}{2}\right)^{2} \times \mathrm{P}$$

Description:
V = Volume of wood
Du = tip diameter
Dp = base diameter
P = Length

The cost analysis is calculated based on supporting data obtained from KPH Telawa. Felling and bucking activities at KPH Telawa use chainsaws, so it is necessary to calculate the machine costs that Perhutani must pay. Jenaro (2018) stated that machine costs include fixed costs (the sum of capital interest, equipment depreciation and insurance), and variable costs (the sum of the costs of fuel, lubricants, repairs and maintenance).

The capital costs are the amount of money paid or calculated account in the amount of money or capital used (Jusnalia, 2022):

$$BM = \left(\frac{(M-R)(N+1)}{2N} + R\right) \times 0.0p$$

Description:
BM = Capital interest (IDR/hour)
M = Tool price (IDR)
N = Tool life (years)
R = Value of use equipment (IDR)
0.0p = Bank interest rate (% per year)

Depreciation costs are calculated based on the economic life of the equipment expressed in years or working hours (Sitohang, 2015):

$$D = \frac{\mathrm{M} - \mathrm{R}}{\mathrm{N} \times \mathrm{T}}$$

Description:
D = Depreciation/depreciation (IDR)
M = Purchase price (IDR)
R = Price of used goods (IDR)
N = Lifetime (years)
T = Tool working time (hours/year)

Insurance fee (Sitohang, 2015):

$$T = (\mathrm{D} + \mathrm{BM}) \times 10\%$$

Description:
Q = Insurance costs (IDR)
D = Dappreciation/depreciation (IDR)
BM = Capital interest (IDR/hour)

Variable costs consist of fuel costs and oil costs as well as machine repair and maintenance costs (Fermana et al., 2019).

$$\text{Variable Costs (TVC)} = \mathrm{BB} + \mathrm{Bo} + \mathrm{Bpp}$$

Description:
TVC = Total Variable Cost (IDR)
BB = Fuel costs (IDR/hour)
Bo = Oil cost (IDR/hour)
Bpp = Maintenance costs

- Machine costs are the sum of fixed costs and variable costs (Suhartana et al., 2013)
- Business costs are the sum of machine costs and operator wages (Hamady, 2022)
- Total costs are a comparison of business costs with activity productivity in each work cycle (Dulsalam et al., 2018).

$$\text{Total Cost (IDR/m}^3\text{)} = \frac{\text{Business cost (IDR/hour)}}{\text{Productivity (m}^3\text{/hour)}}$$

Multiple regression analysis was carried out with the aim of finding out the relationship between the independent variable and the dependent variable. Multiple regression analysis has the following equation:

$$Y = a + b_1X_1 + b_2X_2$$

Description:
Y = Productivity
a = Constant
X_1 = Volume
X_2 = Effective Time

III. RESULTS AND DISCUSSION

Characteristics of Teak in KPH Telawa

The main vegetation in the Perum Perhutani KPH Telawa forest area is teak (*Tectona grandis* L.f.), which is the majority of commercial crops cultivated. The distribution of teak plants from under 10 years old to 47 years old or more forms plantation forest formations with a homogeneous stand structure. The samples in this study were taken from Plot 204-D, RPH Ngaren, BKPH Kedungcumpleng, with a diameter range of 20-29 cm, which had been cleared 1 year previously.

The harvesting process in the field is carried out in accordance with the working hours agreed upon by the crew, namely 07.00-16.00, with break time at 12.00-13.00. Based on the Decree of the Board of Directors of Perum Perhutani Number 700/KPTS/Dir/2019, after a Felling Order is issued, the Perhutani Assistant/Head of BKPH carries out felling activities by forming a work team (crew). The crew is divided into 3 (three) sections, namely the felling crew, transportation crew, and reception crew at a wood collection point (TPK). Each crew consists of 4 people, and in the felling crew, there is one chainsaw operator. The research was conducted with the felling crew in charge of carrying out felling activities, starting from preparing the necessary equipment and materials, until the tree fell down. From the 36 teak tree samples observed during logging and stem division activities, they had a total volume of 5.8 m^3 and an average volume of 0.16 m^3.

Working Time for Felling and Bucking

Working time is defined as the length of time required during activities to complete a job (Wulan et al., 2020). Working time is divided into effective working time and ineffective working time. Effective working time is used by chainsaw operators to carry out main activities in logging work elements, in this study total average time was 305.6 seconds/tree. Meanwhile, ineffective working time is time used by chainsaw operators outside of main activities such as resting (drinking and talking), total ineffective working time in this study was 22.6 seconds/tree. Complete data regarding working time for felling and bucking can be seen in Fig 2.

Time measurements starts when the operator starts clearing the area around the tree to be felled, turns on the chainsaw and begins felling activities. Felling and bucking was carried out using a STIHL MS 382 chainsaw. Based on the results of the research carried out, the time results for each work element were obtained which are presented in Fig 2.

Table1. Working Time for Felling and Bucking
Tabel1. Waktu kerja penebangan dan pembagian batang

No *No*	Felling & Bucking Work Elements *Elemen kerja penebangan dan pembagian batang*	Total Average Time (seconds per tree) *Waktu total rata-rata (detik/pohon)*
1	Elements of Effective Work *(Elemen kerja efektif)*	
	a. Clean the area around the tree *(Pembersihan area sekitar pohon)*	5.9
	b. Turning on the chainsaw *(Menyalakan mesin chainsaw)*	3
	c. Determining the fall direction *(Menentukan arah rebah)*	13.5
	d. Making backcut and undercut *(Menentukan takik rebah dan takik balas)*	96
	e. Branch cleaning *(Membersihkan cabang)*	45.6
	f. Bucking *(Pembagian batang)*	141.6
	Total Elements of Effective Work *(Total elemen kerja efektif)*	305.6
2	Ineffective Work Elements *(Elemen kerja tidak efektif)*	
	a. Repair the chain *(Memperbaiki rantai)*	12.8
	b. Rest *(istirahat)*	6
	c. Chatting *(Mengobrol)*	3.8
	Total Ineffective Work Elements *(Total elemen kerja tidak efektif)*	22.6
	Actual Time *(Waktu kerja actual)*	328.2

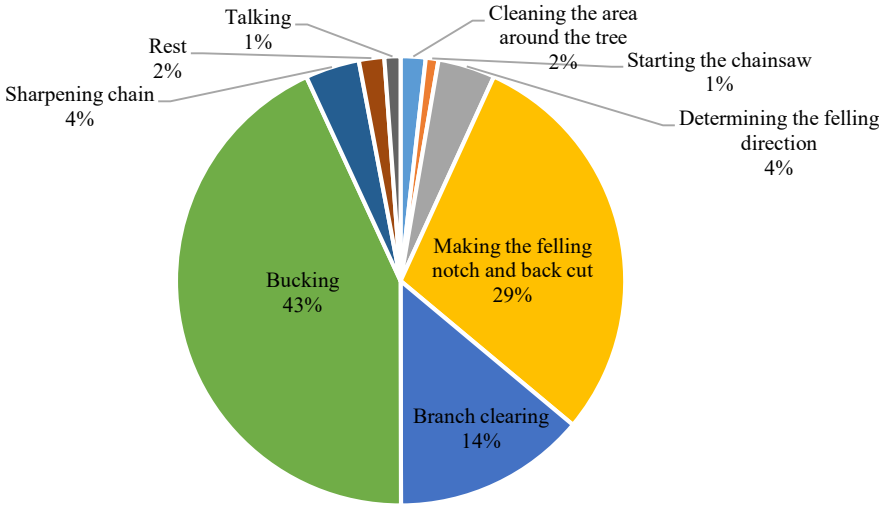

Figure 1. Percentage of Felling & Bucking Work Elements in KPH Telawa
Gambar 2. Persentase elemen kerja penebangan dan pembagian batang

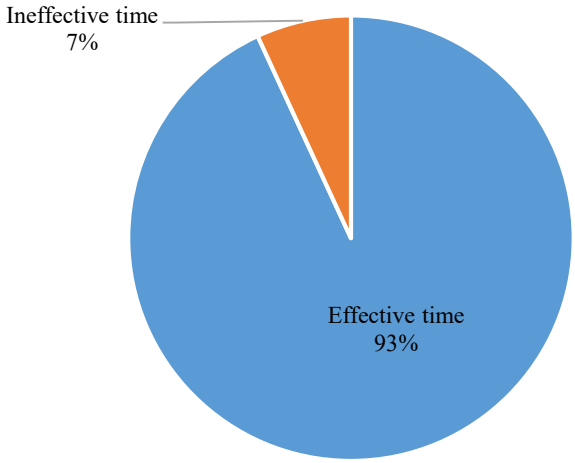

Figure 2. Comparison of Working Time for Felling & Bucking in KPH Telawa
Gambar 3. Perbandingan waktu kerja untuk penebangan dan pembagian batang di KPH Telawa

The largest effective working time is bucking, which is 43% of the total working time, and the largest ineffective working time is chain filing, which is 4% of the total working time. Based on the use of working time, a comparison between effective and ineffective time is obtained which is presented in Figure 3.

It can be seen that the total effective time for felling activities is 93% and the ineffective time is 7%. To increase productivity, what is done is to reduce working time by halving the ineffective time wasted (Gautama et al., 2019). In line with this, if ineffective time is reduced by 50%, total working time will decrease by 3.5% so that actual productivity will increase by 3.5% from before. It is known that the actual productivity value is 1.66 m^3/hour, then based on this assumption, if the effective time is reduced by 50%, productivity will increase to 1.72 m^3/hour. There was an increase in actual productivity of 0.06 m^3/hour. Assuming working hours are 8 hours per day, in one day if ineffective time is reduced by 50%, KPH Telawa can produce a greater volume of wood, namely 0.48 m^3 or 3 trees based on the average volume. This can be a consideration for KPH Telawa to increase productivity.

Felling and Bucking Productivity

Productivity is the result of an activity's work within a certain time (Dulsalam et al., 2018). KPH Telawa implements a system where logging activities are carried out followed by bucking activities. Therefore, in this study, felling and bucking productivity were calculated as one. The results of research on felling and bucking productivity in KPH Telawa are presented in Table 2.

Table 2. Felling and Bucking Productivity at KPH Telawa
Tabel 2. Produktivitas kerja penebangan dan pembagian batang di KPH Telawa

Observation Component *Komponen Pengamatan*	Felling and bucking of Teak wood *Penebangan dan pembagian batang kayu jati*
Average volume (m^3) *Volume rata-rata (m^3)*	0.16
Effective working time (hours) *Jam kerja efektif (jam)*	0.0849
Actual time (hours) *Waktu Aktual (jam)*	0.1865
Effective productivity (m^3/hour) *Produktivitas kerja efektif (m^3/jam)*	1.80
Actual productivity (m^3/hour) *Produktivitas aktual (m^3/jam)*	1.66

Table 3. Previous Research
Tabel 3. Penelitian Terdahulu

Location *Lokasi*	Researcher *Peneliti*	Equipment *Peralatan*	Diameter Class (cm) *Kelas diameter (cm)*	Tool Age (years) *Umur alat (tahun)*	Number of samples *Jumlah sample*	Productivity (m^3/hour) *Produktivitas (m^3/jam)*
KPH Randublatung	Setiani (2016)	*Chainsaw* STIHL 070	-	2.5	31	1.551
		Tecogold Chainsaw 700	-	3	31	1.744
KPH Madiun	Nofiasari (2018)	*Chainsaw* STIHL 707	10-54	5	37	1.185
KPH Madiun	Pratama (2018)	*Chainsaw* STIHL 707	10-70	-	11	0.97
		Chainsaw STICHNO	10-65	-	11	1.02
KPH Madiun (BKPH Brumbun)	Noerbayti (2022)	*Chainsaw* STIHL 070	-	10	35	2.76
KPH Telawa		*Chainsaw* STIHL MS 382	20-29	25	36	1.80

Based on Table 2, it can be seen that the productivity value of logging and bucking with an average effective time of 5.093 minutes is 1.80 m^3/hour. The productivity value of felling and bucking distribution with an actual time of 5,479 minutes is 1.66 m^3/hour. Effective productivity is the result of a comparison between the volume of trees resulting from felling and bucking with effective working time (Jenaro et al., 2018). Meanwhile, actual productivity is a comparison between the volume of trees resulting from felling and the distribution of trunks with actual working time which consists of effective working time and ineffective working time.

Effective productivity is used as comparative data against research that has been conducted previously. Previous research regarding logging productivity and distribution of teak stands in several KPH's can be seen in Table 3.

It can be seen that the results of researches, the productivity of felling and bucking of teak stands in KPH Telawa were higher than KPH Madiun by Pratama (2018), KPH Madiun by Nofiasari (2018), and KPH Randublatung. The productivity value of logging and bucking in KPH Telawa is higher than in several studies other than in KPH Madiun by Noerbayti (2022), however the productivity value in KPH Telawa is not much different from several of these studies. This difference could be caused by differences in the conditions of the research location, age class, number of samples, and stand diameter class in each KPH. According to Gautama et al. (2019), the larger diameter of the tree, the more work time will increase, as well as the weather, climate and topography which influence the work time for felling and bucking activities.

Low productivity can be caused by damage to the chainsaw which originates from the chainsaw operator's lack of understanding regarding the care and maintenance of the tool, resulting in short service life and high damage rates, as well as the chainsaw operator's work experience affecting the resulting productivity (Priyonggo, 2014). Based on previous research, the chainsaw used at KPH Telawa has the shortest service life, namely 2 years. Increased productivity can be caused by replacing machine components so that the rpm produced can be greater, so that the resulting productivity is higher (Priyonggo, 2014). Differences in productivity are also caused by differences in work elements measured in each KPH.

Deforestation can have serious impacts on the environment, biodiversity and local communities if not managed wisely (Fujiyanti, 2023). Therefore, currently KPH Telawa is implementing a Reduced Impact Logging (RIL) system which can maintain land in good condition. The implementation of RIL is expected to provide maximum benefits for KPH Telawa through increased productivity. This is in line with research Suhartana & Yuniawati (2011)

which shows that the application of RIL techniques increases company profits in the form of an increase in production of 6% per year. Besides, at KPH Telawa, the backcut are made as low as possible from the ground surface. This is done because teak is a highly commercial wood, so the volume of wood harvested is optimal and can reduce waste. Furthermore, to cut down sloping trees on flat or sloping land, the direction of fall does not follow the direction of the tree's slope but takes into account the damage (slipping) and damage to lower plants to a minimum. This is not done with conventional logging techniques.

Effect of Volume and Effective Working Time on Productivity

The normality test is carried out with the aim of testing the distribution of data in a group of data or whether the variable is normally distributed or not (Khasanah, 2021). In this study, the distribution of data was tested using the Kolmogorov-Smirnov test and the Shapiro-Wilk test. Based on the Kolmogorov-Smirnov test, a significance value (Sig.) was obtained of 0.076 and the Shapiro-Wilk test obtained a significance value of 0.179. So that in accordance with the basis for normality test decision making, namely Sig. > 0.05, then the data is normally distributed.

Multiple regression analysis is used to predict changes in the value of certain variables when other variables change (Sugiyono, 2010). In this research, multiple regression analysis was used to determine the effect of variable X including volume (X_1) and effective time (X_2) on logging productivity and stem (Y). The regression equation obtained in this study is as follows:

$$Y = 1{,}696 + 8{,}301\ X_1 - 14{,}550\ X_2$$

Based on the regression equation, it can be seen that:

1) The constant value of 1.696 indicates that when both variables X_1 and X_2 are equal to zero, the productivity will increase by 1.696
2) The regression coefficient for the volume variable (X_1) has a positive value of 8.301, indicating that if volume increases by 1% assuming the other independent variables are constant, there will be an increase in productivity of 8.301.
3) The regression coefficient for the effective time variable (X_2) is negative 14,550, indicating that if the effective time increases by 1% assuming the other independent variables are constant, it can affect a decrease in productivity of 14,550.

Based on the interpretation of the regression equation model, this is in line with research conducted by Dewi (2023) that the volume produced is directly proportional to productivity, while effective time is inversely proportional to productivity.

The coefficient of determination (r^2) obtained in this study was 0.83. It can be interpreted that the independent variables, namely volume and effective time, can influence various levels of productivity by 83%, while the remaining 17% is influenced by other factors not tested in this research. Several factors that can influence productivity include field conditions, skid distance, and operator skills (S. Suhartana and Yuniawati 2023).

Cost Analysis of Felling and Bucking

The cost of felling and bucking is calculated based on productivity data and cost components incurred during felling and bucking activities. Felling and bucking cost can be calculated using secondary data from KPH Telawa.

Based on Table 4, it can be seen that the total effective cost of harvesting is obtained from calculating effective productivity and operational costs. The total effective cost results were IDR34,120.08/m^3. According to research conducted by Setiani (2016), the cost of logging teak in KPH Randublatung is IDR28,415.98. Apart from that, there is research conducted by Hamady (2022), with logging costs at BKPH Parung Panjang amounting to IDR32,960.82/m^3. Based on these two studies, it can be seen that there is no big difference in the logging costs incurred. The felling cost standard for KPH Telawa is IDR35,000/m^3,

Table 4. Costs for Felling and Bucking at KPH Telawa
Tabel 4. Biaya penebangan dan pembagian batang di KPH Telawa

No *No*	Cost component *Komponen Biaya*	Total cost *Biaya Total*
1	Fixed cost (*Biaya tetap*)	990 (IDR/hour)
	a. Depreciation (*Depresiasi*)	520,833 (IDR/hour)
	b. Capital interest (*Bunga modal*)	379.17 (IDR/hour)
	c. Insurance (*Asuransi*)	90 (IDR/hour)
2	Variable costs (*Biaya variabel*)	10,478.47 (IDR/hour)
3	Machine cost (*Biaya mesin*)	11,468.47 (IDR/hour)
4	Operator wages (*Gaji operator*)	49,800 (IDR/hour)
5	Business costs (*Biaya Usaha*)	61,268.47 (IDR/hour)
6	Total cost (*Biaya total*)	34,120.08 (IDR/m^3)

KPH Telawa uses a contract work system with ownership of the equipment belonging to the operator. The wage system is carried out using a cubic system which is
paid once a week. The tool used in teak harvesting activities at RPH Ngaren, BKPH Kedungcumpleng is the STIHL MS 382 chainsaw which has been used for 2 years. Based on KPH Telawa wage rate data for 2023, the standard cost of logging using a piecework/contract system IDR35,000/m^3. There is a difference of 2.52%, which is IDR879.92. The difference represents a profit for the chainsaw operator.

The productivity of felling and Bucking can influence the production costs. Suhartana and Yuniawati (2017) stated that choosing the right wood harvesting equipment can reduce production delays so that productivity values will increase. This shows that the higher the productivity value, the lower the production costs incurred. Implementing the RIL system can increase teak wood production so that by increasing the productivity of logging and bucking, the production costs incurred will also be lower. This is in line with research conducted by Ningrum & Yuniawati (2023) that the application of RIL techniques can provide lower production costs compared to conventional techniques. According to Noerbayti (2022), the total costs incurred were calculated based on cost analysis if Perum Perhutani had its own chainsaw, which was IDR 22,152.33/m^3. Training chainsaw operators can increase work productivity. The use of chainsaw for felling activities is considered more effective and efficient to increase productivity and minimize forest harvesting costs.

CONCLUSION

The volume and effective time influence the productivity of felling and bucking. This research found that the effective productivity of logging and bucking at the Ngaren RPH, Kedungcumpleng BKPH, Telawa KPH was 1.80 m^3/hour, while the actual productivity was 1.66 m^3/hour. The total effective cost of felling and bucking using a STIHL MS 382 chainsaw is IDR 29,373.45/m^3. There is a cost difference of 2.52%, namely IDR 879.92, with the standard harvesting costs from Perhutani KPH Telawa.

Knowing productivity and costs can be considered when preparing forest management strategies, especially harvesting teak stands. Further studies need to be carried out regarding harvesting costs so that KPH Telawa can obtain maximum profits. Apart from that, further research needs to be done on the activities of yarding, loading and unloading, and transporting teak stands. Application of RIL in every component of wood harvesting activities needs to be increased so that work productivity can reach RIL standards and can reduce company production costs.

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AUTHORS CONTRIBUTION

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Author contributions:

Designs and ideas are carried out by PW and RR; data collection and data analysis are carried out by PW; manuscript writing by PW, RR, and AA; The repair and finalization of the mansukrip was carried out by RR and AA.

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