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Implementation of Bin System Units for Efficient Harvest Transportation in the Palm Oil Agroindustry

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ABSTRACT

This study aims to determine the effect and effectiveness of transporting fresh fruit bunches using the Bin System. This study method uses direct observation in the field regarding the Transportation of fresh fruit bunches from the collection point to the palm oil processing factory using the Bin System. Then carry out an analysis of the benefits obtained from transporting fresh fruit bunches using the Bin System, the time required to fill the bins, the number of fresh fruit bunches transported, the rate of fresh fruit bunches sent to the palm oil processing factory, and the total costs incurred for Transportation of fresh fruit bunches using Bin System per month.

Based on the results of the studies that have been carried out, it appears that the time required to fill the bins is 81 minutes. The number of transporters is two people, the daily rate of fresh fruit bunches sent to the factory is six rates, and the total costs incurred for transporting fresh fruit bunches with Bin System in one month for Rp 23.985.222.

Keywords: *Oil palm, Transportation of fresh fruit bunches, Bin System*

Introduction

Oil palm (Elaeis guineensis Jacq.) is a vegetable oil-producing plant cultivated in tropical areas such as Southeast Asia, Latin America, and Africa. Oil palm plantations have bright prospects to be developed as a source of foreign exchange for the country, expanding employment opportunities, preserving natural resources, and as a vehicle for development[1][2]. The development of the area of oil palm plantations in Indonesia has increased rapidly from year to year. The agricultural sector's growth, especially in the oil palm plantation sub-sector, is due to the rapidly growing demand and price of Crude Palm Oil (CPO) products in the world market in the last few decades. Correct cultivation techniques greatly support the success of oil palm management. The oil palm cultivation process consists of several stages, including land clearing, nursery, maintenance of immature plantations (TBM), and maintenance of mature plantations (TM). Based on the steps of oil palm cultivation, harvesting is the most decisive activity in the oil palm business[3][4].

The harvesting process is one of the critical determinants of palm oil production. Palm oil productivity is determined by how much oil is obtained and the quality of the oil. The yield of oil obtained is influenced by various factors, including the implementation of harvesting oil palm [5][6].

Harvesting success is influenced by preparing harvesting facilities and infrastructure, fresh fruit bunches (FFB) maturity criteria, and harvesting management[7]. They stated that the road network system in plantations is one of the critical factors for collecting and transporting FFB. Many works in an area or block cannot be carried out smoothly due to the inadequate road or bridge infrastructure, which hampers operational activities. Roads must be passable by FFB transport vehicles in all weather [8].

Qintara et al. (2022) state that the tool's work efficiency helps know the actual work in the field. The value of work efficiency is seen from the actual conditions of the area. Based on the results of actual observations obtained, working time, standby time, repair time, and delay time. The delay time obtained from the field is due to factors such as post-rain road conditions, road repairs, and support tools such as Water trucks and Main Holes, resulting in Dump trucks waiting in line. The standby time factor occurs due to rain, fog, and road conditions[10][11].

Therefore, an alternative is needed so that FFB can be immediately sent to the PKS, where one of the alternatives is to use the Bin System to transport FFB from TPH to PKS. Fresh and freshly cut FFB should be

shipped and processed at the palm oil mill as soon as possible. This is to the statement [12], which states that the harvest delivery to the factory must be as fast as possible so that the fruit harvested today can be processed directly and the free fatty acids are not high. The Transportation of harvested FFB should not take too long, a maximum of 8 hours after harvest. If it is more than 8 hours, the Free Fatty Acid (ALB) will increase, impacting the low quality of Crude Palm Oil (CPO) and tiny yields. Extensive oil palm plantations with different harvests for each afdeling, as well as the condition of the plantations being far from the factory, so in this case, it is not easy to regulate the entry of Fresh Fruit Bunches (FFB) to the factory[13].

The successful management of FFB transportation must meet the four targets of FFB transportation: 1) Maintain daily FFA production of 2-3%. The lack of smooth Transportation to PKS has the risk of causing this impact. 2) Maintain the capacity or smooth processing of PKS. 3) Maintain the security of FFB in the field. Transport arrangements must ensure that fruit is delivered to the mill at the stipulated time. 4) Keeping costs (rupiah per kilogram of FFB) for Transportation to a minimum. FFB transportation management must produce competitive and efficient costs [14][15].

Research Methods

The implementation of this study began on October 2, 2022, and until December 18, 2022, at Division III, PT Sarana Titian Permata 2 oil palm plantation located in Tanjung Rangas Village, Seruyan Hilir District, Seruyan Regency, Central Kalimantan Province[16][17].

Tools and materials

The tools and materials used during the study "Implementation of Bin System Units for Efficient Harvest Transportation in Palm Oil Agroindustry" can be seen in Table 1.

Table 1. Tools and Materials

No	Tools and materials	**explanation**
1	Mini Tractor with *Scissor Lift*	The tool collects fruit from TPH and lowers it into the Bin.
2	*Prime Mover*	The truck (Toyota Dyna) has a hydraulic system, so it can raise bins onto the truck, unload fruit at the PKS, and unload empty containers.
3	Bin	Serves as a fruit collector with a load capacity of 7-8 tons.
4	Stationery	To record when observing
5	Camera	Observation activity documentation tool.
6	*Stopwatch*	Tool for measuring time when observing.

Observational Method

The observation method used is[18][19]:

1. Direct practice in the field

Observing the FFB Transportation process using the Bin System method

2. Analysis of the work of the tool

This method analyzes the work results of the Bin System in transporting FFB, including the time it takes to transport FFB to the Bin until it is complete, the number of FFB transporters, and the rate of FFB sent to the PKS.

3. Interview method

This activity was carried out to complement the data obtained in the field. This method is carried out by interviewing and discussing with divisional assistants, transport supervisors, truck operators, scissor lift operators, and fruit transporters.

4. Literature study

This method collects data by reading and studying the literature on palm oil plantations.

Figure 1. Plantation Road Infrastructure Dominated by Wavy Roads and Plantation Land
(Source: Personal Documentation (2022)

Observation Step

The stages of work carried out are:

1. Preparation

The preparatory stage includes preparing tools and materials and selecting locations to be sampled for observation.

2. Data Collection

Observations were made when the tool started working. Then the data is taken: the number of fruit carriers, how long it takes to fill the Bin to complete, and the fruit delivery rate in one day. Each data collection must be recorded.

3. Data Analysis

The data that has been obtained from the observations are then analyzed using a data tabulation system (grouping data into a table

Results and Discussion

Bin System Unit Equipment Implementation

FFB transportation is a part of production planning and control. The production process will run smoothly if the supply of raw material, namely FFB, is always there and available, but by keeping FFB from piling up. This is because FFB must be processed immediately. FFB stored for too long will reduce the quality of the ingredients[17]. FFB suitable for processing must go through a quality harvesting stage and optimal supervision. This statement also supported the opinions of [18] that harvest evaluation needs to be done by checking the quality of the harvesters' harvest quality, both the harvested fruit's quality and the quality of the harvesters. Harvest evaluation is done daily by the harvest foreman, assistants, and the Quality Control Team. Inspection of the quality of palm oil pulp is carried out to determine the level of losses and losses due to leftover fruit, unharvested ripe fruit, loose fruit, over-pruning, midribs and others, while fruit quality inspection is carried out when harvesting activities take place at the yield collection site (TPH).

The Bin system unit is a system for transporting FFB harvested from the TPH to the palm oil mill for processing. The system consists of two transport vehicles and a bin. The first transport vehicle is Scissor Lift, and the second is Prime Mover [19]. The price amount is one of the essential considerations for consumers in purchasing transportation services, in addition to considering the performance of transportation operations and service quality. Generally, the transportation pricing strategy is based on cost. Cost is essential in forming prices or transportation rates charged to consumers. Understanding cost drivers in Transportation is necessary. Various factors determine transportation fares. The main factors affecting transportation fares are distance, weight, and density.

Scissor Lift

Scissor Lift is a type of small tractor that carries a small tub with a capacity of 2-3 tons, whose job is to load the FFB collected at the yield collection point (TPH) to the Bin has been placed in the harvested block area. In one division, divided into two units Scissor Lift. For more details, see Figure 1. In the harvest

transportation of the Bin system, the role of mobility is still using a tractor unit. State that a tractor is one of the tools and machinery for agricultural cultivation. A tractor is a vehicle specifically designed for high traction at low speeds or pulling trailers or implements used in agriculture or construction. The primary purpose of using machines in agriculture is to increase work productivity and change heavy work to be lighter[1].

Figure 2. A Tractor Pulling a Scissor Lift (Source: Personal Documentation (2022)

Prime Mover

Prime Mover, trucks with a hook lever (Hooklift) with a hydraulic work system, transport bins that are full to the PKS, and place the containers to the correct location at the harvest location. In one division, there are two units of Prime Mover. To be more clearly seen in Fig. 2.

Figure 3. Prime Mover (Source: Personal Documentation (2022)

Bin

Bin is a place to collect fresh fruit bunches of oil palm, which will be sent to the PKS, with a 7-8 tons capacity. In one division, usually, four bins are available. To be more clearly seen in Fig. 3**.** Miro (2012) *in* Ngapiyatun et al. (2021) states that the Bin system is a system for transporting harvested FFB to the palm oil mill for processing. The system consists of two transport vehicles and a bin. The first transport vehicle is the scissor lift. A container with a capacity of 9 tons will be filled with 4-5 scissor lift trips. The bin system consists of certain facilities, flows, and control systems that allow goods to move from one place to another efficiently.

Figure 4. Bin (Source: Personal Documentation (2022)

Bin System Unit In Harvest Transportation

Transportation of crops with the Bin system unit equipment consists of two stages of Transportation, namely Transportation using a Scissor Lift and transport using a Prime Mover.

Transportation Using Scissor Lift

Transportation using *Scissor Lift* is the Transportation of FFB from TPH, where the Scissor Lift goes along the Collection path and loads the fruit in the TPH into the tub (Figure 4). After the bins are complete, the FFB is lowered into containers at the crossroads between the Collection and Main roads.

Figure 5. Transportation of FFB from TPH Using Scissor Lift (Source: Personal Documentation (2022)

The main factor for smooth Transportation is the condition and maintenance of roads. Harvest transportation is generally hampered not because of a lack of means of Transportation but because of inadequate road conditions. It is essential to pay attention to the Transportation of fruit so that the number of bundles transported must not exceed the transport capacity. If it exceeds the power, it can damage the transportation equipment and roads, which in the end, will require a lot of money to complete. [19].

Figure 6. Fruit transport workers arrange fruit in truck lorries (Source: Personal Documentation (2022)

Transportation Using Prime Mover

Transportation using Prime Mover is the second stage of Transportation, where Prime Mover. This is useful for transporting full bins and bringing them to the palm oil processing factory. During Prime Mover went to PKS with the Bin that was full earlier, Scissor Lift continued to collect fruits from TPH and drop them into other bins.

Comparison of FFB Transportation Methods and Systems with the Dump Truck Method.

Data from the comparison results were taken directly in the field by comparing the Transportation using the Bin System method with manual Transportation now to the Dum truck. The comparisons taken are the comparison of filling time to the Bin and the dump truck (Table 2), the amount of fruit hauling power (Table 3), and the comparison of the number of rates each day (Table 4). According to Abidin (2017) *in* Kristian et al. (2021), if the transportation process can run smoothly, the benefits obtained include ALB daily production of 2-3%, affecting the smoothness or processing capacity of the factory, supporting FFB in the field, and saving transportation costs to a minimum.

Table 2. Filling Time to Bak Bin (Source: PT Sarana Titian Permata 2)

Tub	Bin Sistem	Dump Trucks
1	76 menit	58 minute
2	83 menit	66 minute

3	90 menit	75 minute
4	79 menit	70 minute
5	81 menit	68 minute
Average	82 menit	67 minute

From the data in Table 2, it can be explained that the time for filling FFB into the Bin is faster by manual method than the Bin System because the manual only works once while the Bin System works twice, namely:

1. TBS is loaded into ScissorLlift.
2. Scissor Lift unloading the FFB that has been loaded into the Bin.

Tarmadja et al. (2022) stated that the factors causing yield loss were hilly or sloping land topography, lowland areas submerged in water, bush conditions on the disk, harvest roads, and TPH. The attitude factor of harvesters' lack of discipline is the most significant contributing cause of yield loss. Yield losses in the form of unreported loose fruit occurred in unsanitary conditions, while loose fruit on the harvest road and TPH was relatively small. Yield loss per harvest is 0.91 kg/ha in hilly topography, while on flat topography, it is 0.52 kg/ha, and on low land, it is 0.49 kg/ha.

Table 3. Number of FFB Transporters (Source: PT Sarana Titian Permata 2)

Day	Bin System	Dum Truk
1	Two persons	Four persons
2	Two persons	Four persons
3	Two persons	Four persons
4	Two persons	Two persons
5	Two persons	Two persons
Rata-rata	Two persons	Two persons

Source: PT Sarana Titian Permata 2

Table 3 shows that the number of fruit transport workers using the Bin System is less than the manual one. This is because loading FFB with the Bin System is not as heavy as loading FFB manually. After all, the loader only loads FFB into Scissor Lift.

Table 4. Number of Rates in One Day (Source: PT Sarana Titian Permata 2)

Hari	Bin System	Dum Truk
1	Six rate	Four rate
2	Six rate	Four rate
3	Five rate	Four rate
4	Six rate	Four rate
5	Seven rate	Four rate
Average	Six rate	Four rate

The data in Table 4 shows that the average rate per day of the Bin System is higher than that loaded manually. This is because loading FFB with Bin The loading system only loads FFB into the Scissor Lift and Scissor Lift, which unloads fruit to bins that have been placed at the intersection between Main road and Collection road, so Prime Mover only needs to bring the containers full of FFB to the PKS. After returning from PKS, Prime Mover can immediately bring full bins to PKS without loading FFB again from TPH, such as loading FFB manually, and FFB can be directly sent to PKS.

FFB Transportation Operational Costs Bin System Method with Dum Truck Method

Table 5. Breakdown of Monthly Bin System Operational Costs
(Source: PT Sarana Titian Permata Running Account Details (November 2022)

No	Prime Mover (Rp)	Scissor Lift (Rp)	Total (Rp)
Solar	5.136.556	1.385.037	6.521.593
Oil	232.048	775.081	1.007.129
Etc	96.900	270.000	366.900

Operator	4.422.600	4.107.000	8.529.600
Loader	-	7.560.000	7.560.000
Total	-	-	**23.985.222**

From the data in Table 5, it can be explained that the details of the Bin System operational costs in one month amount to IDR 23,985,222.

Table 6. Details of Monthly Dump Truck Operational Costs
(Source: PT Sarana Titian Permata Running Account Details (November 2022))

No	Dum Truk
1 Solar	Rp 7.690.000
2 Oli	Rp 299.000
3 Biaya onderdil	Rp 278.106
4 External servis	Rp 900.000
5 Biaya ban	Rp 1.588.501
6 Lain-lain	Rp 109.999
7 Operator	Rp 4.452.600
8 Pemuat	Rp 8.640.000
Total	Rp 23.958.206

From the data in Table 6, it can be explained that the details of the Dum Truck operational costs in one month amount to Rp 23.958.206.

From the data in Table 5 and Table 6, the operational costs of the Bin System and Dum Trucks per month are not much different. In terms of fuel, the Bin Sistem is more economical when compared to the Dum Truck, and this is because the prime mover only raises the Bin that is placed on the ground, namely at the intersection between Collection road and Main road which has been fully loaded by the Scissor Lift, without taking any more fruit. At TPH, and in terms of vehicle maintenance, the maintenance of the Bin System is guaranteed. Besides that, the Collection road will be better maintained. This is more appropriate for applications in the Bin Sistem field if it is placed in a division that is quite far from the PKS and in areas where the Collection road cannot be traversed by trucks. This is supported by a statement from Hiola (2018) that the critical factors for optimizing transportation costs were obtained after conducting surveys and analysis studies. The purpose of obtaining an essential element for optimizing transportation costs is to get the potential efficiency of transportation costs because transportation costs are one of the cost components in an industry's production activities.

All stages of the harvest transportation process require management governance, starting from the preparation process to the implementation of the harvest transportation so that unexpected events do not occur and the yield loss during the FFB mobilization process to the factory does not occur during the trip. Yield losses that occur during the harvesting process in the plantation area will increase due to a weakened harvesting control system and during the transportation process to the factory, which often lacks supervision from the foreman and the transport crew.

The FFB transport cycle is the time it takes for a truck to depart from the factory, travel to the plantation, load FFB at the TPH block, and return to PMKS. This cycle includes distance and road quality conditions. The difference in the distance between the plantation blocks from which the FFB came, and the level of road damage also determines the transportation time [24](Krisdiarto *et al*., 2019).

Conclusion

Transporting FFB using the Bin System speeds up the delivery of FFB to the OPM so that the FFB sent to the OPM can be maximized daily, and the fruit carrying capacity is less. It is more appropriate to be placed for divisions far from the OPM and in areas with Collection roads. Truck impassable. The suggestions that can be taken from the results of this research study include; 1. Further study is needed on applying the Bin System in hilly areas, and 2. Other studies are required on the number of Bin System units the company needs to send optimal production targets to the Palm Oil Mill.

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