JUMEBIN: Journal of Management, Economics, Business, and Investment
Vol 1, Issue 2, December 2025, Page 43-49
ISSN: 3110-0511 (Media Online)

Optimization of Crude Palm Oil (CPO) Transportation Costs at PT Pelita Jaya Using a Transportation Model

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Abstract. As a company engaged in the field of *CPO transportation* , PT Pelita Jaya is also present in carrying out expeditions from the loading location to the destination (unloading). The company faces challenges in allocating a total of 900 tons of *CPO* from three PKS PT PTPN IV (Bah Jambi, Dolok Hilir, Pabatu) to three destination depots (PT MNA, PT KPBN, PT SMART) to achieve the lowest cost. This study aims to optimize the cost of *Crude Palm Oil (CPO) transportation* at PT Pelita Jaya. The type of data used is primary data with data collection through interviews and observations field. Researchers use a transportation model as a quantitative approach from Operations Research. Solutions are sought using three methods: *Northwest Corner (NWC), Vogel's Approximation (VAM),* and *Stepping-Stone.* with *POM QM for Windows* as tool supporters data processing . The results identified the optimal allocation that minimizes total costs: Bah Jambi PKS (340 tons) is allocated entirely to PT MNA; Dolok Hilir PKS (260 tons) is allocated entirely to PT SMART (260 tons); and Pabatu PKS (300 tons) is allocated to PT MNA (60 tons), PT KPBN (200 tons) and PT SMART (40 tons). The application of this model has proven successful in providing strategic recommendations to minimize logistics costs and improve distribution efficiency at PT Pelita Jaya.

Keywords: Transportation Model, Shipping Cost Optimization, *North West Corner (NWC*), and *VAM*

1. INTRODUCTION

The essence of distribution lies in its function as a bridge for product distribution from producers to end users The palm oil industry is a major contributor to the country's foreign exchange, with CPO products occupying a central position among Indonesia's leading commodities. Efficiency in the *CPO supply chain* , particularly in the logistics and transportation segments, has a direct impact on a company's global competitiveness. *CPO logistics* in Indonesia is characterized by geographical challenges (archipelagos), varied infrastructure, and complex transportation modes (land, sea, and river) [1] . Logistics management plays a crucial role in companies managing goods distribution channels effectively and efficiently. This includes planning, implementing, and controlling the flow of products, information, and funds from the point of origin to the point of consumption [2] . This is because, which crucially integrates production activities with consumption. [3] . Optimizing the distribution network not only impacts the speed and reliability of supply, but also directly affects the company's cost structure. In reality, transportation costs often contribute a significant percentage of the total operating costs *of CPO* , which can reach 10% to 20% of the cost of goods sold (COGS) [4] ; [5] . Factors that trigger these high costs include inefficient route allocation, limited storage tank capacity, fuel costs, and *lead time issues* [6] .

Crude Palm Oil (CPO) transportation service company located in Tanjung Morawa, is facing a classic dilemma in logistics management. This dilemma is how to allocate and deliver the volume of *CPO* produced from the three Palm Oil Mills (PKS) owned by PT PTPN IV to various ports or depots (PT MNA, PT KPBN, and PT SMART) that serve as final destinations, with limited fleet capacity and *delivery schedule demands* while achieving the lowest total transportation costs [1] . This challenge is driven by the company's desire to maximize profits and try to minimize transportation costs in order to maintain margins amidst *CPO price fluctuations* . Without a systematic and quantitative-based approach such as the Transportation Model, allocation decisions can be subjective, often relying solely on intuition or old practices. This carries a high risk of causing inefficiencies, such as uneven route utilization, idle fleets , or inflated operational costs due to unnecessary *empty haulage* [6] . Thus, the application of the Transportation Model becomes a vital analytical intervention to transform *CPO allocation decisions* from a subjective process to a data-driven optimization process.

The problem of determining the optimal route is also a modern logistics context which is a very complex multi-criteria challenge and is influenced by the convergence of various factors. These factors include operational costs (fuel, vehicle overhead, delivery time constraints and lead times) [7] , resource availability (fleet and driver capacity), real-time traffic conditions, road infrastructure quality (especially in areas with geographical disparities), and compliance with applicable transportation regulations [1] . To overcome this multi-dimensional challenge, route optimization models, especially those based on linear programming, can be a crucial analytical solution. These models enable companies to plan truly efficient routes, which focus not only on the shortest distance but also on minimizing total costs subject to all operational constraints [8] . By mathematically formulating constraints and objectives, the application of route optimization models can significantly reduce a company's logistics costs and at the same time increase customer satisfaction through delivery accuracy and timeliness. Therefore, this route optimization not only provides partial benefits for the freight forwarding function, but also serves as an integrated fundamental strategy to improve the company's overall operational efficiency and strengthen competitiveness in the market [9] .

Transportation modeling is a specialized method in linear programming (Operations Research) designed to solve the problem of selecting the correct and optimal path. Transportation modeling methods generally begin by finding an initial solution using techniques such as the least-cost method, followed by iterating over the optimal solution using the *MODI (Modified Distribution) method.* [10] . Cost minimization can also use the *North West Corner (NWC) model* and *Vogel Approximation* [11] . This model allows companies to systematically reduce transportation costs by balancing two main variables, namely the capacity of supply of goods (from the source) and demand for goods (to the destination) [12] . Because in business activities, transportation and distribution have a large role in contributing to the formation of company competitiveness [13] . This process begins by formulating real problems into objective functions (equations that must be minimized) which are subject to a series of operational constraints (supply and demand capacity) [14] . The goal is to ensure that the allocation of company resources, such as *CPO product transportation routes* at PT Pelita Jaya, is carried out in an objective and *data-driven manner,* thereby minimizing expenses without sacrificing the fulfillment of needs and ultimately supporting increased profitability and competitiveness in the market. In addition, [7] emphasizes that optimization of transportation costs is also able to increase the accuracy of delivery times *(on-time delivery)* which has a direct impact on the satisfaction of the recipient of the goods. The application of Transportation Models is particularly relevant in the *CPO industry* , where commodity volumes are very large and costs per kilometer are highly sensitive to the company's final profit [1] .

Recent studies have demonstrated the effectiveness of this model in optimizing agro-industrial logistics. For example, [15] and [16] specifically demonstrated that by modeling the allocation of *CPO* from mills to distribution points, companies can identify shipping schemes that offer significant savings compared to conventional distribution patterns that may have been implemented. Research conducted by [17] and [18] proved that the implementation of *the NWC* and *VAM methods* in shipping goods can result in optimized shipping costs, including decision-making in selecting shipping route options from pickup locations to destinations. The use of POM QM for Windows in this transportation model also provides an accurate and efficient tool in processing data to be processed [19] and [20] . Therefore, the application of the transportation model in the case of PT Pelita Jaya is expected to provide an optimal and cost-effective *CPO allocation solution.*

This research focuses on the utilization of models from the Operations Research discipline, namely the transportation model, to solve this allocation problem. To achieve transportation cost efficiency, this research applies *the Northwest Corner, Vogel's Approximation* , and *Stepping-Stone methods* [3]. Data analysis is supported by the use of *POM QM for Windows.* [20] , with the main target of minimizing the cost variable (Z) without exceeding the supply availability and ensuring that all demand is met [21] . Where this approach has proven successful and effective by considering factors such as distance, warehouse capacity and demand from various stores in handling product allocation [22] . The main objective is to formulate the transportation problem of PT Pelita Jaya into a mathematical model, finding an optimal solution that shows the quantity of shipments between source and destination points. This research will provide data-based strategic recommendations to minimize the company's total logistics costs [23] .

2. METHODOLOGY

This research was conducted at PT Pelita Jaya A *Crude Palm Oil (CPO)* transportation service company was the object of the study. The data used were primary data collected through interviews and observations conducted in November 2025. The research method used was a quantitative approach. descriptive [24] , where the collected data is in numerical form and processed using *the POM QM For Windows application* to analyze the research problem. This quantitative data is supported by primary data obtained through field research, namely a combination of observation and direct interviews with one of the employees at the research location [25] . In addition, this study also uses library research *from* various references such as journals and books. Specifically, PT Pelita Jaya acts as an intermediary for *CPO transportation* between PT PTPN IV and several partner companies, such as PT MNA, PT KPBN, and PT SMART. PT PTPN IV has three palm oil mills (PKS) which are the locations for *CPO collection* , namely in Bah Jambi, Dolok Hilir, and Pabatu. Each PKS has a different storage capacity.

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ISSN: 3110-0511 (Media Online)

3. RESULTS AND DISCUSSION

3.1 Results

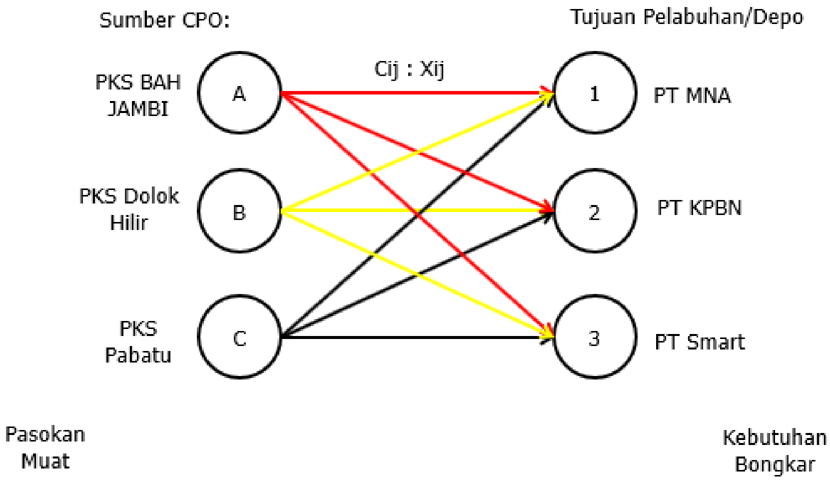

Figure 1. Transportation Model for CPO Transport by PT Pelita Jaya

The Bah Jambi palm oil mill has a storage capacity of 340 tons, while the Dolok Hilir and Pabatu palm oil mills have storage capacities of 260 tons and 300 tons , respectively . These values result in a total aggregate of 900 tons. The supporting data used in this study are summarized in the following table:

Table 1. Palm Oil Mill (PKS) Capacity

Dispantch Area	Capacity (volume)
PKS Bah Jambi	340 tons
PKS Dolok Hilir	260 tons
PKS Pabatu	300 tons
TOTAL	900 tons

Source: PT Pelita Jaya capacity data, November 2025

To complement the previously presented PKS capacity data, this study also collected demand data at each destination port. In the process, the three PKS ship CPO *through* PT Pelita Jaya to three main depots: PT MNA, PT KPBN, and PT SMART. PT MNA's unloading requirements in November 2025 are 400 tons, PT KPBN's 200 tons, and PT SMART's 300 tons. Thus, the total accumulated volume reaches 900 tons. The data analyzed in this study are presented in the following table:

Table 2. Port/Depot Requirements

Partners	Number of Requests (volume)
PT MNA (Tanjung	400 tons
PT KPBN (Belawan)	200 tons
iPT SMART (Belawan)	300 tons
TOTAL	900 tons

Source: PT Pelita Jaya capacity data, November 2025

In the process of transporting palm oil in the form of *CPO* from the PKS located in Bah Jambi, Dolok Hilir, Pabatu, oil trucks are used. The data used in this study are presented in the following table :

Table 3. Costs Transportation of *CPO* from PKS to Destination Depot

From	Cost per ton (in thousands of Rp)		
PT PTPN IV Regional 2	To PT MNA (Depot)	To PT KPBN (Depot)	To PT Smart (Depot)
PKS Bah Jambi	760	1,490	1,510
PKS Dolok Ilir	720	1,160	1,190
PKS Pabatu	630	1,080	1,110

Source: Processed Transportation Cost Data of PT Pelita Jaya, November 2025

3.2 Discussion

Based on the data from the three previous tables, the transportation model formulation was constructed using *the Northwest Corner, Vogel's Approximation* , and *Stepping-Stone methods.* This analysis integrates the capacity of the Bah Jambi PKS, Dolok Hilir PKS, and Pabatu PKS with distribution costs to each depot. The detailed calculation of transportation costs at PT Pelita Jaya is as follows:

Table 4. Stepping-Stone Method

	PT MNA	PT KPBN	PT Smart	PKS Capacity
PKS Bah Jambi	X_{11} 760	X_{12} 1490	X_{13} 1510	340
PKS Dolok Hilir	X_{21} 720	X_{22} 1160	X_{23} 1190	260
PKS Pabatu	X_{31} 630	X_{32} 1080	X_{33} 1110	300
Depot Requirements	400	200	300	900

Source: Data Processing of Capacity, Demand and Transportation Costs of PT Pelita Jaya, November 2025

The optimal cost calculation in the table above is done by implementing the *Stepping method. Stone* uses the equation below:

$Z = 760X_{11} + 1490X_{12} + 1510X_{13} + 720X_{21} + 1160X_{22} + 1190X_{23} + 630X_{31} + 1080X_{32} + 1110X_{33}$

Limitation:

$X_{11} + X_{12} + X_{13} = 3760$

$X_{21} + X_{22} + X_{23} = 3070$

$X_{31} + X_{32} + X_{33} = 2820$

$X_{11} + X_{21} + X_{31} = 2110$

$X_{12} + X_{22} + X_{32} = 3730$

$X_{13} + X_{23} + X_{33} = 3810$

The following data has been processed using the Northwest Corner (NWC) method, resulting in the following results:

Table 5. Initial *CPO* Transportation Costs of PT Pelita Jaya

	PT MNA	PT KPBN	PT Smart	PKS Capacity
PKS Bah Jambi	340 760	X_{12} 1490	X_{13} 1510	340
PKS Dolok Hilir	60 720	200 1160	X_{23} 1190	260
PKS Pabatu	X_{31} 630	X_{32} 1080	300 1110	300
Depot Requirements	400	200	300	900

Source: PT Pelita Jaya Capacity, Demand and Transportation Cost Data Processing, November 2025

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A. Total Initial Shipping Cost
340 (760) + 60 (720) + 200 (1160) + 300 (1110) = 866,400

Table 6. Results of Northwest Corner Method Processing

	PT MNA	PT KPBN	PT Smart	PKS Capacity
PKS Bah Jambi	340 / 760	X_{12} / 1490	X_{13} / 1510	340
PKS Dolok Hilir	0 / 720	200 / 1160	60 / 1190	260
PKS Pabatu	60 / 630	X_{32} / 1080	240 / 1110	300
Depot Requirements	400	200	300	900

Source: PT Pelita Jaya Capacity, Demand and Transportation Cost Data Processing, November 2025

Determining minimum costs using the Northwest Corner (NWC) method is done with the following steps:

a. Transportation Costs for Stage 1 Allocation are
340 (760) + 200 (1160) + 60 (1190) + 60 (630) + 240 (1110) = 866,000

b. Trial And Error Fix
ADDITIONAL COST: From PKS Pabatu to PT MNA Depot = 630
From Dolok Hilir PKS to PT SMART Depot = 1190 +
1820
COST REDUCTION: From Dolok Hilir PKS to PT MNA Depot = 720
From PKS Pabatu to PT SMART Depot = 1110 +
1830

The iteration process does not need to be continued because the difference in the results of reducing costs per unit compared to increasing costs already shows an optimal value with a very small difference.

Northwest Corner method, the initial procedure in *the Vogel's Approximation method* begins with the creation of an initial transportation table:

Table 7. Land processing *Vogels Approximation* Method

	PT MNA	PT KPBN	PT Smart	PKS Capacity
PKS Bah Jambi	340 / 760	1490	1510	340
PKS Dolok Hilir	720	1160	260 / 1190	260
PKS Pabatu	60 / 630	200 / 1080	40 / 1110	300
Depot Requirements	400	200	300	900

Source: PT Pelita Jaya Capacity, Demand and Transportation Cost Data Processing, November 2025

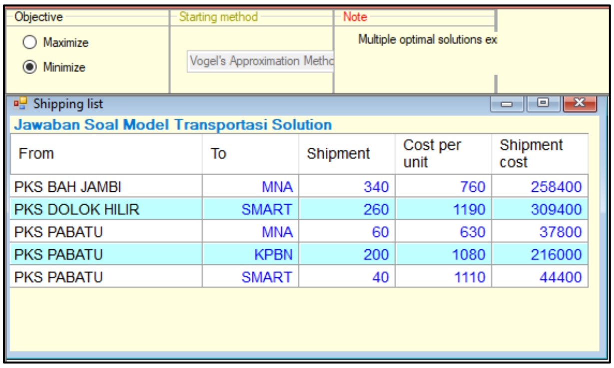

Figure 2. POM PM Data Processing for Windows

The calculation results of the three transportation methods show that the product allocation with minimum cost is:

a. 340 tons of *CPO* from PKS Bah Jambi were allocated to the PT MNA depot as much as 340 tons of *CPO.*
b. 260 tons of *CPO* from the Dolok Hilir PKS were allocated to the PT SMART depot as much as 260 tons *of CPO.*
c. 300 tons of *CPO* from Pabatu PKS were allocated to the PT MNA depot as much as 60 tons of CPO, the PT KPBN depot as much as 200 tons, and the PT SMART depot as much as 40 tons *of CPO* .

4. CONCLUSION

Based on results obtained with implementation method transportation , in particular Method *Stepping-Stone, Northwest Corner,* and *Vogels Approximation* , research This succeed identify cost the most optimal operation of third factory coconut palm oil (PKS) PT PTPN IV to various harbor or depots of PT MNA, PT KPBN, and PT SMART for reduce cost operational in transportation *CPO* PT Pelita Jaya as intermediary loading and unloading . Research results show that transportation *CPO* with cost lowest involving delivery 340 tons *CPO* from PKS Bah Jambi allocated to the PT MNA depot. Then , 260 tons *CPO* from Dolok PKS Downstream allocated to the depots of PT MNA, PT KPBN, and PT SMART. Meanwhile that's 300 tons from PKS Pabatu allocated to PT MNA and PT SMART depots. Steps optimization This can assist PT Pelita Jaya in manage capital effectively maximum , minimize cost transportation *CPO,* and designing policy more distribution efficient .

Acknowledgements

Writer express deep gratitude to Almighty God One on completion article study This is entitled " Optimization " Cost Transportation *Crude Palm Oil (CPO)* at PT Pelita Jaya Using the " Transportation Model ". Success study This No off from support , guidance , and Work The same from various the party that has give contribution intellectual and support operational during the research process taking place on the field . Awards as high as possible writer give thanks to management of PT Pelita Jaya, in particular department logistics and operations , which have give permission study as well as crucial primary data access through session interviews and observations in November 2025. Transparency information regarding PKS capacity data , depot requirements , and structure cost delivery become foundation main in mathematical model formulation in writing this . Thank you sincere love also author convey to Mr. Ahmad Albar Cape as lecturer mentors and colleagues author , above directions strategic , constructive correction , and knowledge transfer knowledge in use device soft The very POM *QM for Windows* help accuracy data processing . In addition that , appreciation given to institutions College of Science Management Sukma Medan who has provide environment conducive academic environment For development research This . Lastly , the author say accept love to all over colleagues member on dedication and work hardness in synergize ideas to study This can come true as contribution for development efficiency logistics industry coconut palm oil in Indonesia.

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