Optimization of South Sumatra Province Rubber Supply Chain with Price Monitoring Application

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Abstract

Problems that occur in the rubber supply chain in the province of South Sumatra cause the supply process or distribution of the results of smallholder rubber processing to be hampered. The scope of this research covers areas in the province of South Sumatra. The purpose of this study is to optimize the rubber supply chain model in the province of South Sumatra from several existing supply chain channels using website-based applications and Quantitative Management (QM) applications for data analysis. The analytical method used is the Linear Programming (LP) method. Transport capacity and labor hours are used as constraint functions while the objective function is optimization. There are three rubber supply chain channels in the province of South Sumatra. From the results of testing the Quantitative Management (QM) application on the first channel with a sample of farmers A1, village collectors B1 and district collectors Z1 in the first supply chain in March 2022, the product solution type X2 is 585.71 and profit X2 = 9745, then the profit is obtained of Rp. 5,707,786. From the results of testing the Quantitative Management (QM) application on the second channel with a sample of farmers A2 and large collectors B2 on the second channel in March 2022, the type A product solution is 276.32 and the profit is X1 = 12125, then the profit is Rp. 3.350.5329. From the results of testing the Quantitative Management (QM) application on the third channel with samples of farmers A3 and B3 on the third channel in March 2022, it was found that the type B product solution was 525 and the profit X2 = 12750, the profit was Rp. 6.693.750. So based on the results of the analysis on the QM application, the optimal profit from the supply chain in South Sumatra is in the third channel.

Keywords:

Optimization, Supply Chain Management, Rubber, Liniear Programming, Price

1. Introduction

South Sumatra Province is one of the provinces on the island of Sumatra, with a total area of 87,017.41 km^2. South Sumatra Province is the largest rubber producer in Indonesia with total production reaching 896.00.42 tons in 2021. The rubber production is produced from plantation land with a total of 1,311,726.83 hectares (BPS Sumatera Selatan, 2021).

Rubber production in South Sumatra Province is produced from smallholder rubber plants. So, to meet the factory's demand, the quality of the production process must be considered and the distribution process is somewhat in accordance with the needs of the rubber processing factory. Supply chain is a system that allows an organization to distribute its production goods and services to customers. The supply chain is a form of network of various organizations that are interconnected with the aim of organizing the optimal procurement or distribution of goods (Herda & Setyawan, 2017).

The optimization of the community rubber supply chain is carried out to maximize cost benefits. So that the concept of optimization is developed for each process in order to achieve the desired maximum demand. This study discusses the concept of community rubber supply chain by using supply chain management to maximize the cost advantage of rubber supply chain distribution with linear programming method. The main contribution of this research is to examine the application of supply chain management in optimizing and solving problems in the rubber supply chain in South Sumatra Province.

2. Literature Review

2.1. Optimization

Optimization is a process to achieve an ideal or optimal value. In the study of mathematics, optimization refers to a problem that is used to find the minimum or maximum value of a real function. In achieving an optimal value, either a minimum value or a maximum value, structurally what is done is to choose a number variable value that can provide an optimal solution. (Mindaputra, n.d.).

2.2. Supply Chain Management

Supply chain management or often referred to as supply chain management is a description of the overall coordination of an activity from the supply chain, the activity starts from the procurement of raw materials and ends with the results of satisfied customers. In a supply chain includes a system consisting of suppliers, manufacturing companies and or service providers, distributors (distribution of goods), wholesalers or retailers who serve as an introduction to products or services to end consumers or end customers.

The purpose of a supply chain management system is to coordinate an activity in the supply chain so that it can be maximized as a competitive advantage and can benefit the end consumers of the supply chain process.. (Jay Heizer, 2015).

2.3. Rubber Plants

Rubber plants are a collection of several trees reaching a height of 25 meters and a fairly large tree trunk diameter. In general, rubber tree trunks can grow upward and straight with tree branches at the top. The most abundant sap content in the stem and the sap content is known as latex (Erni, 2013).

The result of rubber plant production is latex production. The quality of the latex of the rubber plant itself is influenced by 2 factors, namely the state of the rubber plant and the growth of the rubber plant. The increase in latex production is carried out through various activities, including cultivating superior clones, fertilizing plants with the right dose and regularly, planting the right rubber system and maintaining good rubber. (Sudjarmoko & Listyati, 2013).

2.4. Agile Development Methodology

Agile software or often referred to as "agile" software development is defined as the interaction between team members and users is considered an important part of developing software. This shows that the development of this agile software copes with the changes. An example of this agile software is Scrum or often called extreme programming.

Extreme programming gives permission to the development team to communicate directly with customers or users or between programmers. Communication that is done all the time in finding things that are not clear is the hallmark of extreme programming. The extreme programming model relies heavily on the form of feedback so that a qualified team member is needed (Shalahuddin, R. A, 2014).

3. Research Methods

In this research, the problems that arise in the rubber supply chain channel will be modeled and solved using a linear programming method approach. The research was conducted in a rubber production and distribution area in the province of South Sumatra. Rubber distribution is monitored using a website-based pricing application.The information system is made using the codeigniter programming language.

Rubber data from the distribution of rubber is used to complete the analysis with the developed system. Furthermore, the data managed by the price application is used as data to optimize the rubber supply chain using a Quantitative Management (QM) application with a linear programming formulation.

The first channel is the rubber supply chain in the form of farmers, small collectors, large collectors and factories. The second channel consists of farmers, middle collectors and factories. The third channel is in the form of farmers, rubber management units and factories.

Data was collected through interviews with farmers, rubber collectors, rubber management units in the province of South Sumatra and observations of the distribution process of rubber production. The data collected includes the number of farmers per rubber collector, the quantity of rubber production based on the type of rubber product and the costs associated with the distribution of rubber products.

In managing the sales profit data for each channel of the rubber supply chain pattern using the QM application, it is used to find out the maximum profit in the distribution cost of the smallholder rubber supply chain pattern.

5. Result And Discussion

5.1 Data Analisys

Research data obtained from direct observations and interviews with related parties, namely farmers, rubber collectors, rubber management units and the plantation office in March 2022. The distribution or delivery period of rubber products in South Sumatra is carried out twice for product A type rubber and four times for product B type rubber. Sales data for the first channel was taken in March 2022 with a data sample of 150 respondents.

Table 1. Average of distribution of First Channel rubber in March 2022

Product	Farmer	small collectors	large collectors
A	300 kg	2500 kg	10000 kg
B	250 kg	2000 kg	8500 kg
Total	550 Kg	4500 kg	18500 kg

Sales data for the second channel was taken in March 2022 with a data sample of 100 respondents.

Table 2. Average of distribution of second Channel rubber in March 2022

Product	Farmer	Middle collectors
A	400 kg	7500 kg
B	350 kg	5500 kg
Total	750 Kg	13000 kg

Sales data for the third channel was taken in March 2022 with a data sample of 80 respondents.

Table 3. Average of distribution of third Channel rubber in March 2022

Product	Farmer	Rubber management units
A	500 kg	9500 kg
B	400 kg	6050 kg
Total	900 Kg	15550 kg

The profit distribution on the first channel is the distribution result in March 2022. The profit on the first channel type A product is Rp. 11,128, - and the profit per kilogram of product type B is Rp. 9.745,-. The profit distribution in the second channel is the distribution result in March 2022. The profit in the second channel type A product is Rp. 12,125,- and the profit per kilogram of product type B is Rp. 10.750,-. The profit distribution on the third channel is the distribution result in March 2022. The profit on the third channel type A product is Rp. 14.125, - and the profit per kilogram of product type B is Rp. 12,750.

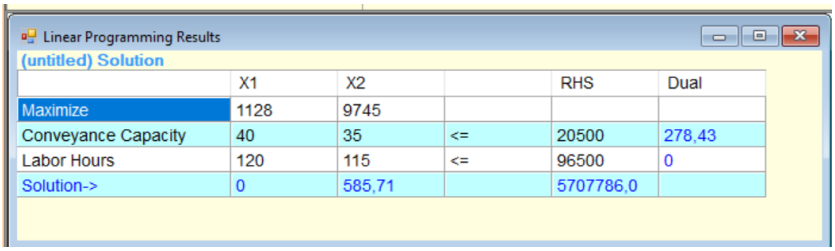
Furthermore, for the constraint function, there are two functions, namely the capacity constraint of the means of transportation and the constraint on the working hours of the workforce. For the first channel, the conveyance capacity is 17,500 kg. Meanwhile, the labor hours constraint ranges from 4 hours of labor with 2 workers and is calculated per second (2 people*4 hours*3600 seconds) around 115,200 seconds.

For the second channel, the conveyance capacity is 10,000 kg. As for the constraints of labor hours, it is about 4 hours of labor with 4 workers and calculated per second (4 people*4 hours*3600 seconds) is around 230,400 seconds. For the third channel, the conveyance capacity is 9,000 kg. As for the constraints of labor hours, it is around 4 hours

5.2 Result Research

a. First Channel

Based on the profit distribution data obtained in the first channel, then the profit data at the farmer level with small collectors and large collectors. The test results using the QM application to optimize profits on the first channel based on the constraints on the first channel are shown in the figure:



Linear Programming Results

(untitled) Solution

	X1	X2		RHS	Dual
Maximize	1128	9745			
Conveyance Capacity	40	35	<=	20500	278,43
Labor Hours	120	115	<=	96500	0
Solution->	0	585,71		5707786,0	

Figure 1. QM Application Test Result on First Channel

From the results of testing the QM application, a solution on the first channel of type B products was obtained, namely a solution of 585.71. So the calculation of the solution X2 = 585.71 multiplied by the profit X2 = 9745. So the maximum profit for the first channel of farmers, small collectors, and large collectors in March 2022 is Rp. 5,707,7856.

Sensitivity analysis in the first channel for farmers, small collectors and large collectors can be seen in the following picture:

Variable	Value	Reduced ...	Original Val	Lower Bou...	Upper Bou...
X1	0	10009,14	1128	-Infinity	11137,14
X2	585,71	0	9745	987	Infinity
	Dual Value	Slack/Surp...	Original Val	Lower Bou...	Upper Bou...
Conveyance Capacity	278,43	0	20500	0	29369,57
Labor Hours	0	29142,86	96500	67357,14	Infinity

Figure 2. Sensitivity Analysis on the first channel

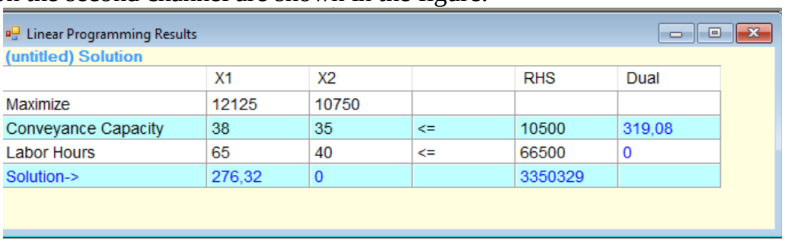
Based on the results of the sensitivity analysis in the image, there are lower bounds and upper bounds that are useful for sensitivity analysis on the first channel:

1. Constraints of conveyance capacity
   - Upper bound: for the process of transporting rubber, the capacity of the conveyance is added to the range of 29369 kg will not change the solution above. If the capacity of the conveyance is increased, it will affect the total cost of the load and the total profit obtained
   - Lower bound: for the rubber transportation process, the lower limit of the transportation capacity is 0 kg so that the transportation capacity cannot be less than 0 kg or none.

2. Labor hour constraints
   - Upper bound: for the rubber transportation process, requires infinity labor hours (unlimited)
   - Lower bound: labor hours should not be less than 67.357 seconds of work so as not to affect the solution above

b. Second Channel

Based on the profit distribution data obtained in the second channel, then the profit data at the farmer level and middle collectors. The test results using the QM application to optimize profits on the second channel based on the constraints on the second channel are shown in the figure:



Linear Programming Results

(untitled) Solution

	X1	X2		RHS	Dual
Maximize	12125	10750			
Conveyance Capacity	38	35	<=	10500	319,08
Labor Hours	65	40	<=	66500	0
Solution->	276,32	0		3350329	

Figure 3. QM Application Test Result on Second Channel

From the results of testing the QM application, a solution on the second channel of type A products was obtained, namely a solution of 276.32. So the calculation of the solution X1 = 276.32 multiplied by the profit X1 = 12.125. So the maximum profit for the second channel of farmers, and middle collectors in March 2022 is Rp. 3.350.329.

Sensitivity analysis in the second channel for farmers, and middle collectors can be seen in the following picture:

Variable	Value	Reduced ...	Original Val	Lower Bou...	Upper Bou...
X1	276,32	0	12125	11671,43	Infinity
X2	0	417,76	10750	-Infinity	11167,76
	Dual Value	Slack/Surp...	Original Val	Lower Bou...	Upper Bou...
Conveyance Capacity	319,08	0	10500	0	38876,92
Labor Hours	0	48539,47	66500	17960,53	Infinity

Figure 4. Sensitivity Analysis on the second channel

Based on the results of the sensitivity analysis in the image, there are lower bounds and upper bounds that are useful for sensitivity analysis on the second channel:

1. Constraints of conveyance capacity
   - Upper bound: for the process of transporting rubber, the capacity of the conveyance is added to the range of 38876 kg will not change the solution above. If the capacity of the conveyance is increased, it will affect the total cost of the load and the total profit obtained
   - Lower bound: for the rubber transportation process, the lower limit of the transportation capacity is 0 kg so that the transportation capacity cannot be less than 0 kg or none.
2. Labor hour constraints
   - Upper bound: for the rubber transportation process, requires infinity labor hours (unlimited)
   - Lower bound: labor hours should not be less than 17.960 seconds of work so as not to affect the solution above

c. Third Channel

Based on the profit distribution data obtained in the third channel, then the profit data at the farmer level and Rubber management units. The test results using the QM application to optimize profits on the third channel based on the constraints on the third channel are shown in the figure:

Linear Programming Results

(untitled) Solution

	X1	X2		RHS	Dual
Maximize	14125	12750			
Conveyance Capacity	25	20	<=	10500	637,5
Labor Hours	65	35	<=	66500	0
Solution->	0	525		6693750	

Figure 5. QM Application Test Result on Third Channel

From the results of testing the QM application, a solution on the third channel of type B products was obtained, namely a solution of 525. So the calculation of the solution X1 = 525 multiplied by the profit X1 = 12.750. So the maximum profit for the third channel of farmers, and Rubber management units in March 2022 is Rp. 6.693.750

Sensitivity analysis in the third channel for farmers, and Rubber management units can be seen in the following picture:

Ranging

(untitled) Solution

Variable	Value	Reduced ...	Original Val	Lower Bou...	Upper Bou...
X1	0	1812,5	14125	-Infinity	15937,5
X2	525	0	12750	11300	Infinity
	Dual Value	Slack/Surp...	Original Val	Lower Bou...	Upper Bou...
Conveyance Capacity	637,5	0	10500	0	38000
Labor Hours	0	48125	66500	18375	Infinity

Figure 6. Sensitivity Analysis on the third channel

Based on the results of the sensitivity analysis in the image, there are lower bounds and upper bounds that are useful for sensitivity analysis on the third channel:

1. Constraints of conveyance capacity
   - Upper bound: for the process of transporting rubber, the capacity of the conveyance is added to the range of 38000 kg will not change the solution above. If the capacity of the conveyance is increased, it will affect the total cost of the load and the total profit obtained
   - Lower bound: for the rubber transportation process, the lower limit of the transportation capacity is 0 kg so that the transportation capacity cannot be less than 0 kg or none.
2. Labor hour constraints
   - Upper bound: for the rubber transportation process, requires infinity labor hours (unlimited)
   - Lower bound: labor hours should not be less than 18375 seconds of work so as not to affect the solution above

5.3 Price App Implementation

The price monitoring application on the rubber supply chain system in the province of South Sumatra is an application that is used to manage rubber distribution transactions in the form of price data for each channel. Here is the price application display:

a. Home Page
is the first page of access and is used for registration and login access to the system

Figure 7. Home Page

b. Registration Page
Registration page is a page to register for first, second and third channel actors

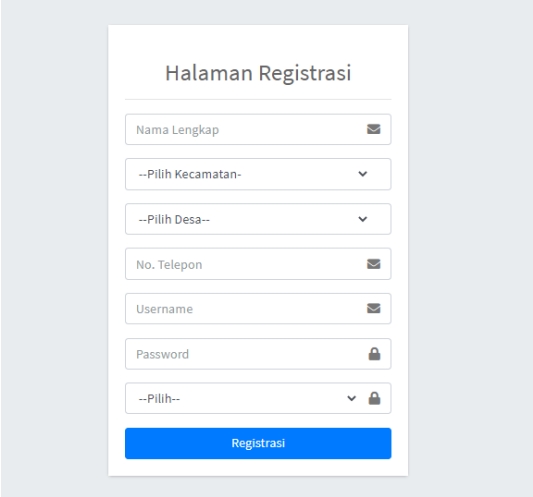


Figure 8. Registration Page

c. Farmer Home Page

The farmer's main page is the page that first appears when successfully logging in at the farmer level.

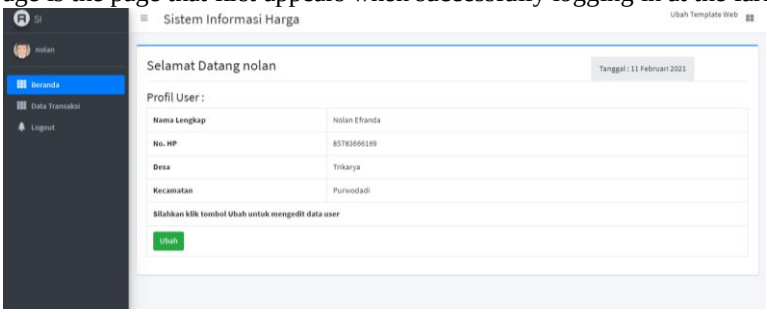


Figure 9. Farmer Home Page

d. Farmer Transaction Page

The farmer transaction page is a page to view rubber sales transactions from collectors

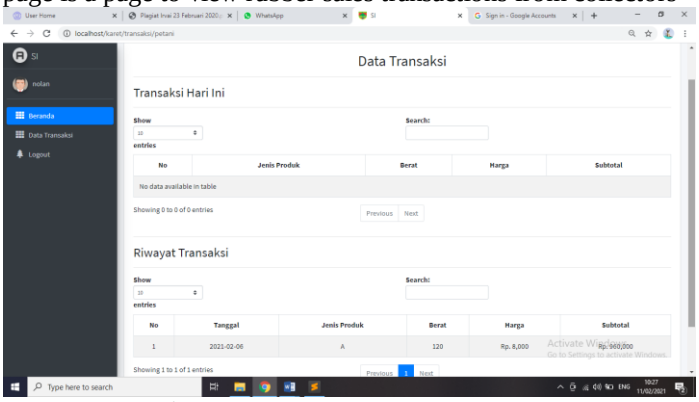


Figure 10. Farmer Transaction Page

e. Colector Home Page

The main collector page is the first page that appears when successfully logged in based on the first, second or third channel collector level

Figure 11. Colector Home Page

6. Conclusion

In this study, we discuss the optimization of the rubber supply chain in the province of South Sumatra. Optimization of the advantages of the rubber supply chain based on data on the production and distribution of each supply chain channel which is managed using an application-based information system. The data is then developed using a linear programming model and processed with the Quantitave Management application to obtain maximum profit optimization results for each channel of the rubber supply chain. Based on the results of optimization using the Quantitave Management application, the optimal profit results from the rubber supply chain in the South Sumatra area are in the third channel, namely farmers and rubber management units.

References

BPS Sumatera Selatan. (2021). *Luas Tanaman Perkebunan (Hektar), 2019-2021*. https://sumsel.bps.go.id/indicator/54/414/1/luas-tanaman-perkebunan.html

Erni, N. (2013). *Usulan Strategi Pengembangan Industri Karet Alam Indonesia*. *9*, 9.

Herda, S., & Setyawan, A. (2017). MANAJEMEN RANTAI PASOK KAYU GAHARU DI KALIMANTAN BARAT. *Jurnal Manajemen Dayasaing*, *18*(2), 92–101. https://doi.org/10.23917/dayasaing.v18i2.4506

Jay Heizer, B. R. (2015). *Manajemen Operasi*. Salemba Empat.

Mindaputra, E. (n.d.). *PENGGUNAAN ALGORITMA ANT COLONY SYSTEM DALAM TRAVELING SALESMAN PROBLEM (TSP) PADA PT. EKA JAYA MOTOR*. 83.

Shalahuddin, R. A, S., R. A. (2014). *Rekayasa Perangkat Lunak Terstruktur dan Berorientasi Objek*. Informatika.

Sudjarmoko, B., & Listyati, D. (2013). *ANALISIS FAKTOR PENENTU ADOPSI BENIH UNGGUL KARET*. 13.

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