ISSN: 2467-9283

OPEN ACCESS

Indexing & Abstracting

Open Academic Journals Index (OAJI), InfoBase Index, Cosmos, ResearchGate, CiteFactor, Scholar Stear, JourInfo, ISRA: Journal-Impact-Factor (JIF), Root Indexing etc.

INTERNATIONAL JOURNAL OF GRADUATE RESEARCH AND REVIEW

Impact Factors*

IBI factor: 3

Impact factor (OAJI): 0.101

SEM-Biotech Publishing

*Kindly note that this is not the IF of Journal

Vol-3, Issue-4

November 2017

Research Article

Modelling Rattan Supply Chain in Palu Special Economic Zone

Husein Hi. M. Soleh

Department of Management, Faculty of Economics, Tadulako University, Palu, Central Sulawesi, Indonesia

Email: salehhg868@ymail.com

Abstract

Rattan is a natural wealth that can be utilized for making of household furniture, office furniture, handycraft and others. One rattan production center is a special economic area of Palu city where the raw materials of rattan can be obtained from several regencies in Central Sulawesi, and the nearest province such as West Sulawesi and Gorontalo. In 2011, the government adopted a policy of prohibiting the export of all types of raw rattan to foreign countries so that the need for raw materials of rattan in the country should increase. The reality in Central Sulawesi actually reduced the supply of raw materials of rattan. Therefore, the procurement of raw material terminals is one of alternative to meet the providers of raw materials of rattan. Palu City as one of the Special Economic Zone area in Indonesia became the object of research in the allocation of raw materials as the main terminal of rattan industry in Central Sulawesi. The purpose of this research is to get the model of allocation determination raw materials of rattan for the rattan industry so as to minimize the total cost. Problem solving of allocation model determination by developing model from previous research with Linear Programming (LP) method. The output of this model is to obtain an optimal allocation determination model in the development of the competitiveness of rattan industry in Central Sulawesi. The total cost of the allocation model is the total cost of purchase, the total cost of transportation from source to the raw material terminal, the total cost of storage in the raw material terminal and the total transportation cost from the raw material terminal to the rattan industry center. If the value of the four variables increases then the total cost will also increase, and if the value of the four variables is reduced then total inbound cost will also decrease. Once the linear programming model is run in Premium Solver Platform V9.0 in Microsoft Excel it will be obtained a value that minimizes the total cost and will improve the competitiveness of the rattan industry in Central Sulawesi.

Keywords: Supply chain model; competitiveness; linear programming.

Introduction

The manufacturing industry is now required to have effective and efficient assets and processes to increase productivity continuously in order to win the competition. In an effort to increase productivity, the company must know the activities that can increase value added (product and / service) and eliminate waste, therefore a lean approach is needed. Lean focuses on the identification and elimination of non-value added activities in the design, production (manufacturing) or operations (for services) and supply chain management directly related to customers (Womack & Jones, 2003). To meet this, all parties involved from the initial process to the end of a product must be able to cooperate well. According to Pujawan (2005), the involvement of these interested parties gave birth to a new concept in 1990 that is Supply Chain Management.

Heizer and Reinder (2004), Supply Chain Management (hereinafter abbreviated as SCM) is part of operational management, first proposed by Oliver and Weber in 1982. In principle, supply chain requires integration of multiple parties involved in the supply chain of a product . Supplier is expected to supply quality raw materials and on time delivery so that the company (focal company) can plan and integrate the overall operational process well. Commitment guarded by the suppliers will assist the company (focal company) in distributing the product to the customer in accordance with the level of service (service level) which has been mutually agreed. While on the consumer side, information on the required amount and payment of ordered products should always be coordinated in order to increase trust among all parties in supply chain management

Supply chain drives the competitiveness of global companies in delivering fast service with high product variety and low cost, so companies can survive in the midst of increasingly fierce competition (Gimenez and Ventura, 2003: 355-363). According to Daryanto (12.0: 806-824), SCM applications can also increase the added- value of a product. Daryanto's research also concludes that companies that implement SCM have the potential to be successful especially in dramatically increasing productivity. World-renowned companies that have successfully implemented SCM concepts include P & G, Wal-Mart, Hawlet Packard, IBM, Chyrler, Dell Computers, and Sun Microsystems.

According to the Indonesia Ministry of Industry (2014), the rattan industry of Indonesia needs more effectively raw materials in their operations. Indonesia is the largest rattan produces country in the world, it is estimated that 80% of rattan raw material worldwide is produced by Indonesia. The second and the third larger producers are Philippines and Vietnam respectively. The sources of Rattan in Indonesia are located in Kalimantan, Sumatra, Sulawesi, and West. Papua. The production of Indonesian rattan was around 622,000 tons /year.

Thus, theoretically the role and contribution of supply chain implementation in an organization / company will be able to give real effect either directly or indirectly to competitiveness. Therefore, the rattan industries in Central Sulawesi and Palu City are expected to apply supply chain system in their production process. This phenomenon is reflected and seen from the flow of raw materials to finished goods ready to be shipped/ exported or in other words integrated from upstream to downstream.

Supply Chain Model

Indrajit and Djokopranoto (2002) explain the main actors having an interest in the flow of goods can be developed a supply chain model, that is a plastic picture of the linkages of the players that can be shaped like a linked link another. Harland (1997), the important point in the supply chain that can be seen as a value-added network stage of processing materials, each defined by input supply, material transformation and demand output. The supply chain model for the forestry sector, especially rattan, is slightly different from the trade and other sectors. The supply chain model from upstream forest is collected, then collected to the factory to small industrial centers and handicrafts downstream to end consumers.

As one of the largest rattan producing provinces in Indonesia, Central Sulawesi contributes to the development of processing-based industries. Central Sulawesi province has the potential of forest resources in the form of timber and non-timber forest products. One of the many non-timber forest products contained in large quantities is rattan. On this basis, an academic study is needed to see and examine the detailed supply chain implementation model of the competitiveness of the rattan industry in Central Sulawesi.

Based on the background of research that has been described previously, then the problem in this research is how to determine the supply chain allocation model of rattan raw materials in the development of competitiveness of rattan industry in Palu Special Economic Zone (KEK). The aims of this research include: 1) the rattan industry supply chain model that can minimize the total cost; 2) modeling the supply chain terminals of raw rattan in improving the competitiveness of the rattan industry in Central Sulawesi. The outcomes of this research are generating the value added of rattan products, the role of supply chain is very important in improving the performance of the parties involved in the supply chain which will ultimately affect the competitiveness of the rattan industry.

Research Methods

This research was conducted by applying heuristic method. The population in this study consists of rattan farmers, rattan processing industry, furniture / furniture industry, and rattan industry in Palu Special Economic Zone.Purposive sampling is used as a technique of determining the sample with certain considerations, Sugiyono (2002). The criteria of respondents who were involvedin this study are:1) Head of Forest Service and Industry Office;2) Rattan raw material management company domiciled in Central Sulawesi;3)Small rattan industries in Palu City area;4) The owners and manager as well as employees who involved in rattan industry in Palu Special Economic Zones. There are several assumptions used in this study include:

1. Demand for industrial centers on fixed rattan. If the request is not fixed then the model will change. In addition, the costs also change.
2. All sources have equal opportunity in supplying to terminal raw materials. The above assumptions relate to the model. If the source does not have the same opportunity then the method used is not linear programming but binary.
3. Raw materials are always available in source and raw material terminals. The above assumptions relate to the model. If the raw material is not always available in source and raw material terminals then the model will change because the method used is binary.
4. Will be established the terminal of raw materials of rattan in the area of Palu Special Economic Zone.

Based on the observations that have been done, the formulation of problems on how to develop the model to decide which are proper raw material terminal location and how much the cost of allocating raw material to minimize the total of costs involved in supply chain. The next step is model development that has been known several things, among others, objectives, criteria, planning time interval, the nature of the model, decision variables taken, the parameters used in the model, model depiction and model formulation. The data are processed using linear programming model in determining the allocation in its completion with the stages as follow:

Objective:

Determine the dynamic location of raw material terminal and dynamic allocation of rattan raw materials. The formula can be seen as follow.

$$Z_{min} \quad \sum_{t=1}^{5}\sum_{j=1}^{5}\left[\left(\sum_{i=1}^{5} Cb_{it}\, X_{ijt}\right)+\left(\sum_{i=1}^{5} Ct_{ijt}\, X_{ijt}\right)+\left(\sum_{k=1}^{7}\sum_{n=1}^{4} Ct_{jknt}\, Y_{jknt} D_{knt}\right)+\left(\sum_{n=1}^{4} Cp_{jnt}\, A_{jnt}\right) + \left(H_{jt}B_{jt}^{+}+E_{jt}B_{jt}^{-}\right)+\left(\sum_{n=1}^{4}\left(H_{jnt}I_{jnt}^{+}+E_{jnt}I_{jnt}^{-}\right)\right)+\left(F_{jt}g_{jt}\right)+\left(a_{jt}g_{jt}\left(1-g_{j,(t-1)}\right)\right)\right]$$

Criteria:

Total purchase cost, transportation cost, processing cost, inventory cost, minimum operational cost and terminal lease.

Interval:

Characterization of discrete time intervals in years.

***Nature*:**

The model to be made is dynamic deterministic.

Decision Variables:

- X_{ijt} : Total number of types of raw rattan sent to raw material terminal j of supplier i in period t.
- Y_{jknt} : Binary variables (0,1), value 1 if the delivery of rattan type n is processed from the raw material terminal j to the rattan finished goods industry and is 0 if otherwise.
- g_{jt} : Declare a binary variable (0.1), is 1 if the raw material terminal is opened (gjt = 1) and is 0 if the raw material terminal is not (gjt = 0).
- A_{jnt} : Jumlah rotan olahan *n* yang diolah di terminal bahan baku *j* pada periode *t*.
- B_{jt}^{+} : The amount of raw rattan inventory at the raw material terminal j at period t.
- B_{jt}^{-} : The amount of shortage of raw rattan inventory at the raw material terminal j at period t.
- I_{njt}^{+} : The amount of inventory of processed rattan type n in the raw material terminal at the end of period t.
- I_{njt}^{-} : The amount of the shortage of inventory of the processed rattan type n in the raw material terminal j at the end of the period t.

Parameters:

- Cb_{it} : The cost of purchasing per ton of rattan species from supplier i in period t
- Ct_{ijt} : The cost of raw rattan transporting per ton from supplier i to raw material terminal j in period t
- Ct_{jknt} : The cost of transporting the processed rattan type n per ton from the raw material terminal j to the rattan finished goods industry in period t
- Cp_{jnt} : Processing cost of processed rattan type n at the raw material terminal j per tonne in period t.
- H_{jt} : The cost of storing the raw rattan in the raw material terminal j per tonne in period t.
- E_{jt} : The cost of shortage of rattan at the raw material terminal j per tonne in period t.
- H_{jnt} : The cost of storing the type of processed rattan n at the raw material terminal j per tonne in period t.
- E_{jnt} : Cost of deficiency of processed rattan type n at the raw material terminal j per tonne in period t.
- F_{jt} : Operational cost of raw material terminal operation j at t jt period: cost of re-opening of raw material terminal j in period t.
- b_{jt} : The closing cost of the raw material terminal j in period t
- r_n : Conversion value from raw rattan to processed rattan species n
- W_{jt} : The storage capacity of the raw material terminal j at period t.
- S_{it} : Supplier supply capacity i in period t
- D_{knt} : Demand of processed rattan type n by rattan industrial goods centers k in period t
- W_t : Limits on the number of raw material terminals that can be opened in period t.

Other Notation:

- *t* : The year of planning (1,2,3,…*T*)
- *T* : Number of years of planning
- *i* : Supplier index (1,2,3,…*I*)
- *I* : Number of suppliers
- *j* : Raw material terminal index (1,2,3,…*J*)
- *J* : The number of raw material terminals
- *k* : Index of rattan goods industry center (1,2,3, *K*)
- *K* : The number of rattan finished goods industry
- *n* : Index of processed rattan type (1,2,3,…*N)*
- *N* : number of processed rattan species
- B_{jt} : The amount of raw rattan inventory at the raw material terminal j at the end of the period t
- $B_{j(t-1)}$: The amount of raw rattan inventory at the raw material terminal j in the period (*t-1*)
- I_{jnt} :The amount of inventory of processed rattan type n in the raw material terminal j at the end of period t
- $I_{jn(t-1)}$:The amount of inventory of processed rattan type n in the raw material terminal j at period t-1

Results and Discussion

Data processing was initially begin with calculating the costs as parameters in the model that is the operational costs of raw materials terminals, transportation costs of transportation from supplier to raw material terminal as well as transportation costs from raw material terminal to small rattan industry center, and inventory costs both raw rattan and processed rattan in raw material terminals. There were five sources of raw rattan, namely Donggala, Parimo, Poso, Touna and Banggai. The number of raw rattan material which can be seen in Table 1. The raw rattan will be delivered to a terminal which is located close to Palu Special Economic Zones. Next, the raw rattan material will be processed into certain types of rattan. The percentage of processed raw rattan material in the terminal can be seen in the following Table 2.

Then the step is to finalize the location model and the allocation of raw materials terminals by giving an input from parameters into the model. Meanwhile, the percentage of inventory can be seen in the Table 3.

According to the results of several scenarios, Palu Special Economic Zones could process more of processed rattan, while several small industries in certain parts of Palu could process small number of processed rattan. The total cost of these scenarios can be seen in the following Table 5

Table 1: The Sources of Raw Rattan

Regencies	**Amount (kg)**
Donggala	182.400
Parimo	242.400
Poso	272.400
Touna	302.400
Banggai	347.400

Table 2: The Percentage of Rattan Processing

Palu Selatan	**Mantikulore**	**Tawaeli**	**Palu Timur**	**Palu Utara**	**Palu Barat**	**KEK Palu**
16.69	16.66	16.67	16.65	16.66	16.66	0.01
0.00	0.00	29.48	27.19	0.00	27.62	15.71
0.00	19.20	9.73	19.71	29.31	22.06	0.00
16.65	16.67	16.66	16.67	16.66	16.65	0.04

Table 3: The Percentage of Inventory Costs Per Each Type of Rattan

Palu Selatan	**Mantikulore**	**Tawaeli**	**Palu Timur**	**Palu Utara**	**Palu Barat**	**Spe.Ec.Zone Palu**
14.29	14.29	14.29	14.29	14.29	14.29	14.29
14.29	14.29	14.29	14.29	14.29	14.29	14.29
14.29	14.29	14.29	14.29	14.29	14.29	14.29
14.29	14.29	14.29	14.29	14.29	14.29	14.29

Table 4: The Percentage of Processed Rattan Received by Industries

Delivery Capacity	**Palu Selatan**	**Mantikulore**	**Tawaeli**	**Palu Timur**	**Palu Utara**	**Palu Barat**	**Spe.Ec.Zone Palu**
50000	8.71	10.89	5.66	17.43	15.25	20.26	21.79
40000	10.00	12.50	6.50	17.83	17.50	17.83	17.83
30000	13.33	15.60	8.67	15.60	15.60	15.60	15.60
20000	14.50	14.50	13.00	14.50	14.50	14.50	14.50
10000	14.29	14.29	14.29	14.29	14.29	14.29	14.29

Table 5: The Total Costs from Simulation

Type of Costs	Scenario				
	10000 (kg)	**20000 (kg)**	**30000 (kg)**	**40000 (kg)**	**50000 (kg)**
transport to terminal	Rp 2.997.075.000	Rp 2.997.075.000	Rp 2.997.075.000	Rp 2.997.075.000	Rp 2.997.075.000
storage	Rp 124.014.000	Rp 124.014.000	Rp 124.014.000	Rp 124.014.000	Rp 124.014.000
open or close operations	Rp 240.000.000	Rp 240.000.000	Rp 240.000.000	Rp 240.000.000	Rp 240.000.000
process fees	Rp 8.107.876	Rp 8.107.876	Rp 8.107.876	Rp 8.107.876	Rp 8.107.876
purchasing cost	Rp 111.057.897	Rp 111.057.897	Rp 111.057.897	Rp 111.057.897	Rp 111.057.897
inventory cost	Rp 623.618.129	Rp 623.618.129	Rp 623.618.129	Rp 623.618.129	Rp 623.618.129
transport to industries	Rp 307.385.714	Rp 615.566.000	Rp 926.665.600	Rp 1.240.882.667	Rp 1.326.414.000
Total	Rp 4.411.258.616	Rp 4.719.438.902	Rp 5.030.538.502	Rp 5.344.755.569	Rp 5.430.286.902

Conclusion

The problems in the research of location determination of terminal allocation of rattan raw materials include modeling of location determination of dynamic facility allocation, multi commodity, two stages by considering inventory and capacity limitation. The problem can be modeled into a non-linear programming mix integer model. Based on the results of data if the location of raw material terminal determination results obtained that in the first year of planning only one terminal of raw materials that opened the KEK Palu. In the 2nd to 5th year of planning, the addition of raw material terminal opening into two raw material terminals are KEK Palu and Baki. The addition of the opening of this raw material terminal to overcome the shortage of supply of raw materials of rattan to rattan goods industry center because of the limited raw material terminal capacity. The total supply chain cost incurred by applying the mix integer model of non-linear programming developed during the planning period is Rp 6,875,237,790.00.

Based on the above conclusions, then the following are suggestions for the relevant parties and further research in order to achieve improvement. The existence of integrated planning between small rattan industry in Palu-Central Sulawesi Province and other entities in rattan chain will help to nominate which is the proper location raw rattan material. Conducting supervision for the authorities on the implementation of raw material terminal operations and allocation of rattan raw materials so that planning can run properly and well. Further research should document the historical data of demand for rattan raw materials as a complete data input in forecasting demand for rattan raw materials.

References

Daryanto. 12.0. *Peningkatan nilai tambah industri rotan melalui supply chain management.* 25 : 806-824.

Gimenez C and Ventura E (2003) SCM as a competitive adventage in Spanish grocery sector. *International journal of Logistic Management.* **14**(5/6): 355-363.

Harland, C. 1997. *Supply chain operational Performance roles, Integrated Manufacturing System.* 8 (2). 70-78

Heizer J and Render B (2004) *Management operations*, Seven Edition. Prentice Hall, New Jersey.

Pujawan IN (2005) *Supply chain* Management. Edisi Kedua Guna Widya, Surabaya

Indrajit ER and dan Djokopranoto R (2002) *Konsep Manajemen Supply chain: Strategi Mengelola Manajemen Rantai Pasokan Bagi Perusahaan Modern di Indonesia*. Grasindo. Jakarta 2002.

Indrajit ER and dan Djokopranoto R (2003) *Konsep Manajemen Supply chain, Cara Baru Memandang Mata Rantai Penyediaan Barang, PT. Gramedia Widiasarana Indonesia*, Jakarta.

Sugiyono (2002) *Metode Penelitian Administrasi*, Cetakan Kedelapan, Penerbit: Alfabeta, Bandung.

Womack J and Jones D (2003) *Lean Thinking*, New York: Simon & Schuster