Optimization of Rattan Raw Material Supply Chain Route Case Study: Rattan Katingan Indonesia

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Abstract : Currently rattan raw material supply is experiencing problems with the supply conditions which hampered and the price rises to 30% in the market of rattan raw material. Kasongan is capital of Katingan regency today, developing rattan industry to supply the demand of internationally and nationally rattan products. The problem of rattan raw material distribution hindered from transport costs because the route followed is very difficult, so the distribution of the supply of raw materials from the forest toward Rattan Industry inflict expensive transportation costs. The transportation system in the *Supply Chain* was developed using a model *Vehicle Routing Problem* with restriction *Capacitated* (CVRP), with the purpose to minimizing the total distance traveled and shipping expense. This model can help rattan national business to select routes and costs must be released to get the rattan raw materials.

Keywords: Rattan Raw Material, Supply Chain, Vehicle Routing Problem with Capacitated (CVRP)

1. INTRODUCTION

Indonesia is one of the biggest rattan producer in the world. However there were peculiarities where raw rattan was hard to obtained in the market. To overcome the problem with the Decree No. 35 /M-DAG/PER/11/2011 the Minister of Commerce has determined that the final export shipping for raw rattan was December 20, 2011. So, after that date, rattan raw materials can be easily obtained. Cessation of rattan exports really has yet to make the furniture industry in the country gets an adequate supply of raw materials. A number of craftsmen still complain of raw material shortage. Even so there are their prices have gone up until 30%. Whereas, since January 1 has banned the export of raw rattan. Even before the decision enforced, rattan entrepreneurs have been reminded, if the export of raw materials is stopped, there will be over supply because the rattan production is within the range of 300 thousand to 400 thousand tons per year. While the domestic industry needs only 15-30 thousand tons. But the fact is not like that. Rattan furniture entrepreneur in Kasongan claims still difficulties in obtaining raw materials.

Case of rattan raw material at the Katingan that occurred at this time, apart from the loss of rattan raw materials market as well as the condition of the transportation costs borne by farmers or rattan gatherers become increasingly expensive as when the export of raw materials is still open, the price of raw material at the former are still the same but at that time, transportation costs become borne by exporters who provide itself of transport fleet or they rent from existing public transport to arrive the dock in the capital of district / province.

Nowadays, rattan raw material distribution system passed the number of different players before end at the entrepreneurs' hands of finished rattan products. There are just past 1-2 players, but there are also passing more than 5 players. Distribution chain of rattan raw materials are from farmers to small trader in the village, from small trader go to medium trader in the sub district, from medium trader go to big trader in the regency, and then sold to the rattan industry in Katingan (Source : Industry Department of Katingan Regency 2013). The more players that must be passed by rattan raw material, means more expensive price. In addition to length of distribution chain, the conditions route that must be travel is quite difficult Because of natural conditions and unpredictable weather make rattan raw materials difficult to obtain.

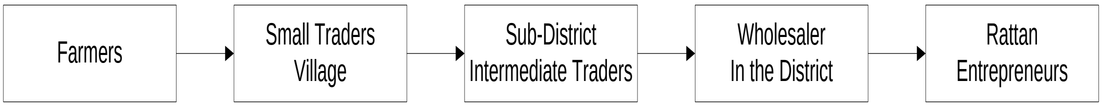

Figure 1 Distribution Chain of Rattan Raw Materials currently at the Katingan

Based on the description, then existing problem in the distribution system and the availability of raw materials from farmers until to national rattan industry, need to find how to solving problems of the distribution route of rattan raw material from the upstream toward the downstream so that the resulting minimum transport costs, resulting in an optimal distribution route and result a optimal solutions to transport costs of rattan raw distribution from upstream to the National Rattan Industry. The expected goals of this research is "A cost calculation model that are expected to be used for various types of rattan or other raw materials that have characteristics or properties similar with rattan raw materials produced in areas inland (upstream)". Results of this study are expected to shorten the distribution chain of rattan raw material, know the places where rattan can be obtained with the amount of production capacity in accordance with the conditions of the place of origin of rattan raw materials, known distribution route channels, known the distance to be traveled and the fees to be paid.

2. STUDY LITERATURE

Vehicle Routing Standards discussed by Bodin et al (1983), Laporte (1992), Onal et al (1996), Caseu and Laburthe (1999) and Laporte et al (2000) purpose to produce route collection from center distributor to various points of the demand which must be served in order that the total distance or transport costs to a minimum. Further research on Vehicle Routing Problem is considering the vehicle capacity as research substance developed by Cordeau et al, (2007), known as Capacited Vehicle Routing Problem (CVRP). VRP is a combinatorial problem that can be categorized as NP-hard problem. Solving VRP using exact optimization methods would require enormous time so many researchers who developed the heuristic method as solution methods. As for some further research on the issue of Vehicle routing problem as follows: Reza Sajjadi et al, (2010) The distribution problem by Metaheuristic Approach For Multi Product Multi Depot Vehicle Routing Problem in which studies on the distribution of multi-product which must be distributed as well as existing the vehicle capacity restriction and solving problem using simulation Annealing and Ant Colony Optimization (ACO), Sara Ceschia et al (2010) Research on Vehicle Routing Problem that produced new variants which complex for vehicle routing problems that arise in the real world where existing fleet is very heterogeneous and cost dependent on operator who have a vehicle, Beibei et al (2011) logistic problems closely relate with VRP where the need for consideration to the operational vehicle restrictions by using Particle Swarm Optimization Algorithm Intelligence (PSO) in the problem of shipping route optimization to meet customer demand conditions through forming of proper distribution channels where goods can get by customer so that the amount of transport time and minimum shipping costs, Peter et al (2010) Problems of vehicle route which have the purpose : 1. Minimize travel costs, 2. Minimize the route length using Hybrid Algorithm approach to solving problem, **Siamak et al** (2012) Solution Meta heuristic Hybrid efficient with consider amount depot and time that must be traveled in vehicle routing sets of that have limited capacity solution using Algorithm Genetic method to find optimal solutions with Tabu Search as a method to make improvements, **Tan et al**, (2012) Problems VRP by using Ant Colony Optimization (ACO) in combination with a heuristic approach that acts as a service improvement tool. Models in the design of a set of routes that start from a single depot for a fleet that serves a number of known demand that obtained the minimum total cost of travel

3. METHODOLOGY

The study begins with an analysis of rattan raw material is missing from the market added with the conditions of transport costs become borne by farmers or rattan gatherers are becoming increasingly expensive and literature of the existing problems, then identify and formulate issues and to set research objectives.

3.1. FORMULATION OF THE PROBLEM

Problems examined in this study relates to how to solve these problems of distribution of rattan from upstream towards downstream so that the resulting minimum transport costs?

3.2. RESEARCH PURPOSES

At this stage determined the expected goals or targets to be achieved in this study are:

1. To produce an optimal distribution route for the supply of raw rattan from upstream towards downstream,
2. Produce transportation costs of raw material supply rattan minimum

3.3. DATA COLLECTION

The type of data that is required in this study consists of two types of primary data and secondary data. Primary data is data obtained through direct observation or interviews. Secondary data are obtained through the company's internal either historical data or records or standards that have been set by the company.

This stage aims to collect data that will be used to test the algorithm. The data taken is a data that contains data requests, the distance matrix of the depot and customer location, vehicle speed, freight and vehicle capacity.

3.3.1. KATINGAN REGENCY

Geographical and Administration

Katingan Regency is geographically located in the area of equator at 112 '00' BT - 113 '45' BT east longitude and 00 '20' LS - 03 '30' LS. Katingan Regency was formed by Law No. 5 of 2002, which is part of the 14 regency / municipalities in the Province of Kalimantan Tengah.

This regency has capital at the Kasongan with an overall area of ± 17,800 km^2. This regency is the result of expansion of the Main Regency namely Kotawaringin Timur into 4 new regencies of Katingan Regency, Seruyan Regency and KotawaringinTimur Regency.

Territorial boundaries of Katingan Regency include:

a. Northern side abut with Malawi Regency, West Kalimantan Province;
b. East side abut with Gunung Mas Regency, Palangkaraya city, and Pulau Pisau Regency;
c. South side abut with Java Sea;
d. West side borders with Kotawaringin Timur Regency and Seruyan.

In government administration Katingan consists of 13 sub districts 154 Countryside and 7 villages. The elongated shape of the regency is following the River Stream Area (DAS) Katingan with a length of ± 650 km and water depth ranges between 1.9 - 5.4 meters. River which estuary into the Java sea through almost the entire sub district at this Regency (Source: BPS of Katingan Regency 2013)

3.3.2. COMMODITY PROFILE OF KATINGAN RATTAN

Rattan is a non-timber forest products which more potential at the Katingan Regency. As forest product, rattan has advantages compare with other forest products. Besides being able to grow naturally, rattan can also be cultivated, as well as an excellent market opportunities.

Relating to the management of forestry resources, then economic development strategy of Katingan Regency certainly cannot be separated from his vision as Production and Trade Center of Rattan Indonesia. Potential productive forest products are abundant; especially rattan is a powerful leverage for developing the regional economy. So Katingan Regency boldly declared as Rattan regency. Katingan continually strive to improve the welfare of the community through the development potential of the region's natural wealth, which can directly touch the aspects of community life with emphasis on empowering farmers and rattan plantation owners along the River stream area (DAS) Katingan, besides timber forest product enterprises more year more decreasing its potential as a result of the impact of illegal logging is increasingly out of control. Katingan Regency government began to cooperate with the Government of Kalimantan Tengah Province, and the Ministry of Forestry to maintain potential and rattan production, rattan marketing and technology transfer of rattan forest product processing as a superior product so Rattan Katingan still exist has a high selling price. Rattan for Katingan Regency is one commodity that is able to sustain the economy to partly communities. Nevertheless, determining superior commodity of one area is not enough if only based on production capacity, the number of business units, absorption of labor, as well as foreign exchange contribution or as supply of domestic needs, but it is necessary to study the competitive advantage of these commodities toward other areas, thus also necessary research so far where the business climate is concerned areas provide continuous support. (Source: Industry Department of Katingan Regency 2013)

3.3.3. TYPE OF RATTAN

Rattan grown / cultivated by the inhabitants of Katingan Regency generally is type of garden rattan / sega rattan (Calamus caesius) and rattan irit / rattan Danum (Calamus trachycoleus). However, there is believed to be another rattan varieties that grow naturally, and has a high selling price. Both types of rattan has quite different physical characteristics but mostly cultivated in the same garden. Difference both type of rattan determine difference cultivation since planting, maintenance, and harvesting until the difference in the selling price of wet rattan. Farm wide and exploitation of rattan garden / sega wet covers 60 per cent, because selling price of rattan garden / sega wet is more expensive than rattan irit, with an average diameter of larger, longer, so that the cutting rattan obtained more amount. (Source; Industry Department of Katingan Regency 2013)

3.3.4. FARM WIDE OF RATTAN

Ecologically rattan can be grown in the lowlands, hills, valleys, swamps until mountains with rocky soil conditions ranging from lime, heath forest, peat swamps, alluvial soil in the river, dry sandy soil, sandy dry soil periodically flooded, as well as areas that are free of puddles. Rattan will grow optimally if the thickness of at least meet 20-30 cm humus. Rattan in Katingan still very likely be developed, particularly in areas that traditionally still maintain this rattan cultivation areas at the along the watershed, such as Katingan River, Samba River, Hiran River, and so forth. (Source: Industry Department of Katingan Regency 2013).

3.3.5. POTENTIAL FARM WIDE

Condition grow which wide so in the this ecology enable rattan grow the totality carpet of forest of Katingan Regency. But under a deal to land use in Katingan, then rattan will be available on the overlay area of 510,377.71 hectares, namely in the area of protected forests and nature reserves (Act No.41 of 1999).

3.3.6. PERPETRATORS CULTIVATION RATTAN, FARM WIDE AND PRODUCTION PER HA, AND TOTAL GATHERER

Rattan plantations owned by the community of Katingan Regency now largely comes from the legacy of its predecessor which traditionally managed. But there is also done with the cultivation, which consists of rattan rega / taman and rattan irit. Table 1 below shows the data in more detail in each village regarding farm wide, production per hectare, and the number of gatherer are available in every village. From 15,547 Perpetrators cultivation of rattan crop production only accommodated by 81 gatherer.

Commodity Superior product of Katingan Regency get production farm wide data which cultivated by community is wide 35,219 hectares, thus 46.4% were believed by communities and local officials attempted by 14,600 households (excluding Mendawai and Katingan Kuala), or equivalent to 38.17% from the total 38 247 KK. (Source : BPS of Katingan regency 2013)

Table 1 Perpetrators Cultivation Rattan, Farm wide and production (per hectare)

Number	**Name of Sub district**	**Rattan potential (Per month)**		**Amount KK Rattan**	**Gatherer**
		Farm Wide (Ha)	**Production (Ton)**		
1	Bukit Raya	5.050	21	906	1
2	Katingan Hulu	7.608	91	1.144	10
3	Marikit	8.100	102	1.190	12
4	Petak Malai	4.400	27	617	2
5	Sanaman Mantikel	5.850	43	1.483	5
6	Katingan tengah	5.700	66	1.396	4
7	Pulau malan	8.028	34	1.646	5
8	Tewang Sangalang	7.960	98	1.972	13
9	Katingan Hilir	11.400	60	1.537	14
10	Tasik Payawan	5.400	75	1.449	10
11	Kamipang	5.100	24	1.260	5
12	Mendawai	370	-	322	-
13	Katingan Kuala	920	-	635	-

(Source : BPS of Katingan regency 2013)

Table 2 this below is the area code, and the production of rattan raw materials that will be distributed is taken from one of the sub districts in exist Katingan Regency that is Pulau Malan.

Table 2 Codes 1 & 2 and Production in Pulau Malan

Information	Code 1	Code 2	Production (Ton)
Tewang Papari	TP	1	2
Tewang Derayu	TD	2	2
Buntut Bali	BB	3	2
Kuluk Bali	KB	4	2
Manduing Taheta	MT	5	2
Manduing Lama	ML	6	3
tumbang Banjang	TB	7	2
Tumbang Lawang	TL	8	2
Dahian Tunggal	DT	9	5
Tewang Karangan	TK	10	3
Tumbang Tungku	TT	11	3
Geragu	G	12	3
Tumbang Tanjung	TAN	13	2
Tura	T	14	1

Table 3 Matrix Distance in Pulau Malan

To / From	Tewang Papari	Tewang Derayu	Buntut Bali	Kuluk Bali	Manduing Taheta	Manduing Lama	tumbang Banjang	Tumbang Lawang	Dahian Tunggal	Tewang Karangan	Tumbang Tungku	Geragu	Tumbang Tanjung	Tura
Tewang Papari	0	23.55	15.13	6.72	6.37	8.13	17.99	10.3	13.44	26.8	18.93	19.75	21.65	25.78
Tewang Derayu	23.55	0	106	28.8	22.15	18.86	39.14	25.07	18.53	15.74	34.6	31.94	29.6	24.95
Buntut Bali	15.13	106	0	13.6	17.05	20.48	8.2	21	84.2	83.4	34.3	26.3	25.01	70.8
Kuluk Bali	6.72	28.8	13.6	0	7.23	10.49	11.24	8.16	14.42	28.92	13.34	15.43	18.61	25.02
Manduing Taheta	6.37	22.15	17.05	7.23	0	3.46	16.84	4.54	7.57	21.73	14.33	14.17	15.41	19.49
Manduing Lama	8.13	18.86	20.48	10.49	3.46	0	20.36	6.65	5.54	18.76	16.78	15.65	15.84	18.19
tumbang Banjang	17.99	39.14	8.2	11.24	16.84	20.36	0	14.85	22.16	35.61	10.23	15.11	19.57	28.67
Tumbang Lawang	10.3	25.07	21	8.16	4.54	6.65	14.85	0	7.37	21.5	10.03	9.5	11.35	17.06
Dahian Tunggal	13.44	18.53	84.2	14.42	7.57	5.54	22.16	7.37	0	14.41	16.17	13.5	11.99	12.62
Tewang Karangan	26.8	15.74	83.4	28.92	21.73	18.76	35.61	21.5	14.41	0	27.65	23.37	19.43	11.12
Tumbang Tungku	18.93	34.6	34.3	13.34	14.33	16.78	10.23	10.03	16.17	27.65	0	4.78	9.62	19.13
Geragu	19.75	31.94	26.3	15.43	14.17	15.65	15.11	9.5	13.5	23.37	4.78	0	4.78	14.15
Tumbang Tanjung	21.65	29.6	25.01	18.61	15.41	15.84	19.57	11.35	11.99	19.43	9.62	4.78	0	9.71
Tura	25.78	24.95	70.8	25.02	19.49	18.19	28.67	17.06	12.62	11.12	19.13	14.15	9.71	0

3.3.7. DATA PROCESSING

3.3.7.1. VEHICLE ROUTING PROBLEM (VRP) METHODS

Vehicle routing problem is a combinatorial optimization problem which aims to determine the most efficient route in an activity distribution with a specified number of vehicles. In addition, according Yeun et al (2008, p 205), Vehicle routing problem is the problem of finding the optimal route for the delivery or collection of goods or services from one or more depots to a number of cities or customers by meeting certain constraints. Thus, Vehicle Routing Problem is a method that can be used to solve problems in the distribution of rattan raw material supply from upstream toward downstream.

The first basic model used by states when G = (V, A) is a graph where V = (1, ... n) is a collection of vertices or nodes that represent the city with depots located in the I, and A is a collection of Arc. With each arc (i, j) i # j associated with the distance matrix C = (Cij). In several paper, Cij expressed as the cost or travel time. There is a similar-capacity vehicles NV located in the depot, VRP models can be formulated as follows:

$$Minimasi = \sum_i \sum_j \sum_v c_{ij} X_{ij}^v \qquad (1)$$

Limitations:

a. Each demand nodes are served by only one vehicle

$$\sum_j \sum_v X_{ij}^v = 1 \qquad j = 1,2, \dots, n$$

$$\sum_i \sum_v X_{ij}^v = 1 \qquad i = 1,2, \dots, n$$

b. Guarantee route continuity (the vehicles coming in on a node must exit the back of the node)

$$\sum_i X_{ip}^v - \sum_j X_{pj}^v = 0 \qquad \forall \rho, v$$

c. vehicle capacity

$$\sum_t d_t \left(\sum_j X_{ij}^v \right) \leq K_v \qquad \forall v$$

d. Availability vehicle is not excessive

$$\sum_j X_{ij}^v \leq 1 \qquad \forall v; j = 1,2, \dots n$$

$$\sum_j X_{iv}^v \leq 1 \qquad \forall v; j = 1,2, \dots n$$

e. elimination subroute

$$X \in S$$

$$X_{ij}^v \{ {0 \atop 1} \leq 1 \qquad \forall v, i, j$$

with:

c_{ij} = Distance / time / costs from node i to node j,

K_v = vehicle capacity to v,

NV = Number of vehicles,

d_i = Consumer demand in node I,

X_{ij}^v = Binary variable which will value if the arc i j passed vehicle and have value 0 if not passed.

Generally VRP, can be interpreted as delivery problems from producers to consumers who focus on searching the vehicle travel route with minimum transportation costs total (Ho, S & Haugland, D, 2004, p 47-64). VRP models like this are usually called classical VRP. In the classical VRP restrictions are observed only in setting the route alone. Whereas in this study VRP models not only focus on setting the route alone, because vehicle capacity constraints are also the focus of this study. VRP model of the vehicle that takes into account the capacity constraints commonly called Capacitated Vehicle Routing Problem (CVRP).

CVRP is a VRP which are given a number of vehicles with its own capacity to serve a number of customer demand which has been known for a commodity of a depot with a minimum transit costs. Therefore CVRP is the same as VRP with the additional factor that each vehicle has its own capacity for the commodity. Thus, Mathematically, the solution for the CVRP same with VRP, but with additional restrictions on the customer's demand total to route Ri not may exceed the vehicle capacity Q. or it can be formulated as follows :

$$\sum_{i=1}^{m} d_i \leq Q \qquad (2)$$

In this research the VRP model to be resolved is Capacitated Vehicle Routing Problem (CVRP). The purpose of this model is to minimize the total of distance and travel cost or route by observe the vehicle capacity. To help obtain decision coming near optimum hence it is done the algorithm designing of Tabu Search.

First solution is needed before algorithm designing of tabu search, in this research the first solution used is done manually using the sweep method, by classifying the nearest points on an area, then determined the stations.

Tabu search was first introduced by Glover around 1986. Glover stated that tabu search is one of the high-level metaheuristic procedures for solving of combinatorial optimization problems. This Tabu search is designed to direction the other methods (or components of tabu search process itself) to quit or avoid from entering into an optimal solution which characteristic of local. Capability of Tabu search to produce near-optimal solution has been utilized in a variety of classical and practical problems from various fields start from scheduling field until telecommunications field.

3.3.7.2. MODEL OF PROBLEMS

The model that will be arrangement is a mathematical function expressing the relation between the various components quantitatively. Modeling this problem is the mathematical equation that will become the starting point of Completion of problems and become the basis for program arrangement in creating solutions.

a. MATHEMATICAL MODEL DESCRIPTION

The model is needed is to searching route of the optimal distribution, so that the distance will be travel become possible optimal to be able to send the entire product as needed with minimum transportation cost based on constraints determined that is capacity and fleet is used.

Product shipped is rattan raw material with distribution lines and patterns that pass through several players, then the rattan raw materials distributed start from farmers to gatherer in the village and then from gatherer in the sub district and then redistributed to the capital of Katingan regency that is Kasongan.

Rattan distribution channel to be modeled is the land transportation. For land transportation using ¾ Truck transport modes. Mathematical models which will be applied in this research is Vehicle Routing Problem with constrain Capacitated and the algorithm used to obtain the best solution is Tabu Search Algorithm.

b. **PREPARATION OF MATHEMATICAL MODEL**

Index in mathematical model of this writing can be described as follows:
i = set of consumers with the index i,
j = set visit (call) that may be performed on the consumer I with index j,
v = set of trucks ¾ or klotok L300 with index v.
The parameters in a mathematical model of this writing can be described as follows:
Cij = distance or cost from node i to node j,
Kv = Vehicle capacity to v,
di = Consumer demand at node i.
Variables in a mathematical model of this writing can be described as follows:
X_{ijv} = vehicles traveling route from node i to node j,
$X_{i\,j}^{v}$ = Binary variable have value 1 if the arc ij passed a vehicle v and is 0 if otherwise.

c. OBJECTIVE FUNCTION

Objective function of equation model in this problem is to minimize travel cost and vehicle travel route v, to shipping the product from farmers to gatherer in the capital of Katingan Regency is Kasongan represented by:

$$Minimize = \sum_{i}\sum_{j}\sum_{v} C_{ij}X_{ijv}$$

d. CONSTRAINTS FUNCTION

Constraints function on this research problem is the vehicle capacity.

e. DATA PROCESSING DETERMINATION DISTRIBUTION SYSTEM

Data processing for the purpose of this research was to determine the distribution route, the distance and the optimal cost in distributing rattan raw material supply, using Tabu Search algorithm refers to a mathematical model that has been described previously.

3.3.7.3. DETERMINATION OF FIRST SOLUTION

1. Input

Input data necessary for data processing in the determination of first solution is the distance between the areas in sub districts with a capital of sub district, the distance between sub district capital with regency capital and so capacity

2. Searching Solution Route Optimal

This step aims to obtain early shipping route based on the pattern of distribution of rattan raw material supply. Then the first solution will be input to determine the best route that will then be optimized by grouping the nearest points of the supplier, this is done to minimize the distance travel from truck. Then of groups calculated the distance between the point and it should be noted that the volume will be transported from each supplier, is limited to the total demand transported does not exceed the capacity of the transport truck. After checking that all the points, which if it is connected then performed scheduling to determine which route trip will be passed by vehicles.

3. Output

Results from the beginning working stage of this form of distribution route that became the first solution for the next working stage using tabu search. The distribution route form travel route that will be passed. From existing trip data it is obtained total of travel distance of trucks and its shipping costs.

Determination of first solution by classifying the area closest with Pulau Malan see image of location map of Pulau Malan sub district Capital

Resource : Google 2013

Figure 2 Location of the capital district to New Kasongan

Here is one example of the first solution of rattan raw materials supply that will be distributed from and to Pulau Malan, namely the distribution from the village or the Farmers / gatherer at the Pulau Malan to City center of Pulau Malan at the Katingan regency. Example Route 1 Pulau Malan (Buntut Bali) - Tura -

Tewang Karang - Tewang Derayu - Dahiang Tunggal – Pulau Malan forming closed network.

Table 4 Initial Solution of Distribution from Farmers / Gatherer to the City center of Pulau Malan

Route	Trip							Distance (Km)						Total(Km)
1	3	14	10	2	9	3		70.8	11.12	15.74	18.53	84.2		200.39
2	3	8	6	5	4	1	3	21	6.65	3.46	7.23	6.72	15.13	60.19
3	3	13	12	11	7	3		25.01	4.78	4.78	10.23	8.2		53
														313.58

Distribution route from Farmers / gatherer to the capital district Pulau Malan at the Katingan regency, divided into three routes with route description as follows:
Route 1 = 3 - 14-10 - 2 - 9-3
= 70.8 km + 11.12 km + 15.74 km + 18.53 + 84.2 = 200.39 Km
Route 1 has a directions route from Pulau Malan toward Tura, Tewang Karang, Tewang Derayu, Dahiang Tunggal, and finish at the Pulau Malan
Route 2 = 3-8 - 6 - 5-4 -1- 3
= 21 km + 6.65 km + 3.46 km + 7.23 km + 6.72 km + 15.13 km = 60.19 km
Route 2 has a direction route from Pulau Malan toward Tumbang Lawang, Manduing Lama, Manduing Taheta, Kuluk Bali, Tewang Papari, Buntut Bali and finish at the Pulau Malan.
Route 3 = 3-13 - 12-11 - 7-3
= 25.01 km + 4.78 km + 4.78 km + 10.23 km + 8.2 km = 53 km
Route 3 has a direction from Pulau Malan toward Tumbang Tanjung, Geragu, Tumbang Tungku, Tumbang Banjang finish at the Pulau Malan

f. **FINAL SOLUTION PROCESSING**

Results of the first solution done the move to change point matrix every routes to get new route. Other data that is needed is the volume of shipping and the distance matrix. The distance from the first solution used as the best current solution that will be replaced if found shorter distance.

For each route has a number of different iterations depending on the number of possible displacement (permutations) that occurred. In this case it is assumed that the same move with one iteration. In each iteration, checking whether the move attribute that is used in the tabu list.

Table 5 below is one of the best examples of a final solution to the process of distribution of rattan raw material supply in Katingan regency with the distribution route from City center of Pulau Malan. The best final solution of the distribution of rattan raw material supply from farmers / Gatherer to City center Pulau Malan is divided into three routes, namely

Table 5 Final Solution Malan Island

Route	Trip							Distance (Km)						Total(Km)
1	3	14	10	2	9	3		70.8	11.12	15.74	18.53	84.2		200.39
2	3	1	6	5	8	4	3	15.13	8.13	3.46	4.54	8.16	13.6	53.02
3	3	13	12	11	7	3		25.01	4.78	4.78	10.23	8.2		53
														306.41

Route 1 = 3 - 14-10 - 2 - 9-3
= 70.8 km + 11.12 km + 15.74 km + 18.53 + 84.2 = 200.39 km
Route 1 has direction route from Sub district capital of Pulau Malan toward Tura, Tewang karangan, Tewang Derayu, Dahiang Tunggal, finish at the City center of Pulau malan by total of travel distance 200.39 km.
Route 2 = 3-1 - 6-5 - 8 - 4-3
= 15.13 km + 8.16 km + 3.46 km + 4.54 km + 8.16 km + 13.6 km = 53.02 km
Route 2 has direction route from the City center of Pulau Malan towards Tumbang Lawang, Manduing Lama, Manduing Taheta, Kuluk Bali, Tewang papari, Buntut Bali and finish at the Pulau Malan with a total distance of 53.02 Km
Route 3 = 3-13 - 12-11 - 7-3
= 25.01 km + 4.78 km + 4.78 km + 10.23 km + 8.2 km = 53 km
Route 3 has direction route from Pulau Malan toward Tumbang Tanjung, Geragu, Tumbang Tungku, Tumbang banjang finish at the Pulau Malan with total distance of 53 km

3.3.8. CAPACITY RAW MATERIALS RATTAN

Route capacity in each region varies depending on each point or suppliers area in each route. Capacity on each route in the table below is based on points in the final solution best area. One example is the capacity on each route in the Ibukota kecamatan Pulau Malan.

Table 6 Capacity in the Ibukota kecamatan Pulau Malan

Route	Production (Ton)					Total (Ton)
Route 1	1	3	2	5		11
Route 2	2	3	2	2	2	11
Route 3	2	3	3	2	2	12
						34

3.3.9. THE NUMBER OF VEHICLES USED TO TRANSPORT CANE

Number of vehicles used in this study are not limited in number on each distribution, because the function of this study is a constraint on the capacity of the vehicle. The capacity of the vehicle used is the capacity of the truck ¾ of six tons. At each regional produce rattan have different capacities. In addition determination of the number of vehicles based on the number of trips and the amount of production in each area included in the service. The number of vehicles to be used can be calculated with the following functions:

$$total\ vehicle\ = \frac{Capacity/Production\ every\ Route}{Capacity\ Truck}$$

Table 7 Number of Vehicles Distribution Malan Island

Number	Area	Total Production Rattan (Ton)	Total of Vehicles (Unit)
1	Route 1	11	2
	Route 2	9	2
	Route 3	12	2
		Total amount vehicle	6

With the amount of vehicles produced as in the above table it is expected that the distribution of rattan raw materials can be scheduled well in accordance with the route have chosen.

3.4. TRANSPORTATION COSTS AND PRICES OF RATTAN

Transportation costs for each km distance at the time of distribution is assumed for the price of fuel at Rp 6,500.00 with a ratio of 1: 7, (1 kilometer requires a fee of Rp. 929, -) plus 30% of Rp. 929, - for unexpected expenses during the distribution so that the total cost of fuel is Rp 1,207.00 per kilometer.

Price of rattan in the capital district level towards the district capital is USD 4,000.00 per kilogram and the price of rattan in the village to the sub-district level is $ 3,000.00, per kilogram but prices also depend on the type of rattan cane itself. For the calculation of the total cost of the price of rattan and distribution costs can be calculated with the following formula:

$$Rattan\ Sale\ Price\ ((\sum S \times \sum V \times P) + (P_r \times C)) \tag{4}$$

where:
Σ S = Total Distance (Km)
Σ V = Number of vehicles (units)
P = Distribution Cost (Rp. / km)
Pr = Price of Rattan (Rp. / Kilogram)
C = capacity of each route (Ton)

Total cost yielded at the time of distribution of rattan raw materials can be seen in Table 8 for type of sega rattan are as follows:

Table 8 Sale Price of Rattan

Number	**Area**	**Amount Distance (Km)**	**Amount Vehicle (unit)**	**Cost Fuel (Rp)**	**Price of Rattan (Rp)**	**Capacity per Route (Ton)**	**Sale price of rattan**
8				**Malan island**			

	Route 1	200.39	2.00	1207	3000	11	Rp 33,483,798.71
	Route 2	53.02	2.00	1207	3000	11	Rp 33,128,005.43
	Route 3	53	2.00	1207	3000	12	Rp 36,127,957.14
				Total Cost			Rp 102,739,761.29

From the above table obtained information as follows:

Route 1: the amount of travel distance to get rattan as far as 200.39 km with the amount of mode trucks used 2 units, rattan price offered per kilogram to Rp. 3000.00 for the kind of rattan Sega, the transport capacity of each route is 11 tons and costs Rp. 33,483,798.71.

If the perpetrators /entrepreneur of rattan furniture want to get the raw materials of rattan can be obtained from 12 local rattan gatherer in Katingan regency that is the Sub district of Kasongan, Bukit Raya, Katingan Hulu, Marikit, Petak Malai, Sanaman Mantikei, Katingan Tengah, Malan Island, Tewang Sangalang Garing, Katingan Hilir, Tasik Payawan, and Kamipang. The entrepreneurs of rattan can calculate in the same way using the model calculations above so that the entrepreneurs rattan cane can estimate their needs and the costs to be incurred.

5. DISCUSSION

From the rattan survey results which sale from farmer generally wet rattan, because farmers want to obtain cash money more quickly, whereas when done processing to be sold in the form of a dry rattan, takes at least 1 week. Delivery of rattan raw materials from farmers using two transport paths that use land transportation and river transportation lines, these tough, unpredictable weather conditions, the origin of rattan raw materials from upstream or forest requires a long travel time making the distribution becomes very expensive.

Currently farmers only have access to the market at the level of small traders in the village. Farmers do not have access to know the shape and structure of rattan market because of low levels of market information is absorbed. The selling price is still a price negotiation, where the tendency is the rattan farmers lack sufficient bargaining power. Small traders in the village of farmers receive wet rattan cane processing raw materials into semi-finished goods or raw materials dry rattan which will be sold to intermediate traders who are in the district.

Transport costs obtained by the standard fee for all regions rattan all the same prices as well as prices of raw materials of rattan, the only difference being the distance course, the shorter the distance to the district then becomes cheaper transportation costs, but on the contrary if the farther from the capital district the transportation costs more expensive. With this cost employers wicker or rattan industry to obtain quality rattan raw materials dry. Will be very different at the time before this model was made, rattan entrepreneurs have to spend extra charge to process wet rattan cane be dried in small traders. Distribution chain of raw rattan from the results of this study becomes shorter so that prices can be cheaper and the quality of the raw materials of rattan can be maintained. In this case the rattan raw materials market control by the government could be more controllable because the chain becomes shorter and cane growers conditions can be optimized further for the training given added value of rattan raw materials so that farmers can sell raw rattan to be higher than they should sell in wet conditions. For more details, rattan chain research proposal can be seen in the image below.

Figure 7 Proposed Rattan Raw Materials Distribution Chain

6. CONCLUSION

Research results on optimization of rattan raw material supply distribution route are :

a. Cost calculation models used in this research can be used to calculate of rattan raw materials transportation cost at the Katingan regency
b. Calculations model also can be used by various types of other rattan or raw materials that have the same characteristics with rattan coming from rural areas (upstream) such as agricultural or forest
c. This research results could shorten the distribution chain rattan of rattan raw material becomes more shorter

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