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Cheapest insertion heuristics algorithm to optimize WIP product distributions in FBS Fashion Industry

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Abstract. The textile industry is one of the 10 commodities of industrial products which are still survives in Indonesia due to the crisis in the year 2009 until 2016. Drawback happened in 2017 by increased the number of demand by approximate 3% compares with previous year. In this case, the research conducted in Small Medium Enterprise (SME) called FBS. SME is a business group that is able to absorb a lot of labor and a source of income for society. SME FBS producing clothing boys and domiciled in Jakarta. To complete FBS product, the WIP products are sent to CMT or depot in Sukabumi. In this study, aims to do the shortest route in the determination of the distribution of WIP product to 10 CMT scattered in the area of Sukabumi. After optimization hapened, the route must be started from the Depot SME FBS Sukabumi-Shell Sand Village – village of Sukamaju Village – Margaluyu Village – Narogong Cicurug, – the village of Parakanlima, Cuguha – Padabeunghar Village – Sagaranten Village – village of Ciherang, Ciguyang, Sagaranten – the village of Bojong Waru, Pasirsalam Village, Purabaya – Students – return to Depot SME FBS Sukabumi with mileage in a single trip of 403.6 kilometers. It spents 10 hours 09 minutes and cost distribution issued amounting to IDR 296,928.52. The route length was optimized 47% from 759.1 become 403.6 kilometers.
Keywords: Distribution, Travelling Salesman Problem, Cheapest Insertion Heuristics Algorithm, Routes, Costs

1. Introduction

The textile industry is one of the 10 commodities of industrial products which are in Indonesia because as one of the biggest labour absorber in Indonesia (more than 1.3 million people directly) of the workforce, more than half (600 thousand people) worked in the textile industry which is also a labour-intensive industry and textile product contribution to GDP (gross domestic product) is pretty significant, although National had come down because of the crisis in 2009 to 2016 [1]. According to the Kemenperin in the period January-March 2017, export of textile industry reached USD 2 billion, this figure is experiencing a rise of three percent compared to the same period in the previous year [4]. Not only the textile industry of textiles products that may develop well, but the IKM (small and medium Industry) are also able to compete in developing domestic products. Small and medium industry (IKM) business group is capable of absorbing a lot of labour and a source of Community income [3]. With the concomitant development of the textile industry sector in the efforts in particular on SME then faced increasing competition, each want to master the market widely.

SME FBS is the small and medium industries which produce clothes of boys. Problems faced by SME FBS namely in the distribution of WIP product from Jakarta to Sukabumi in the Village Office which became Purabaya gatherers or depot to IKM FBS. In which the Depot SME FBS Sukabumi funneling WIP product to 13 CMT (Cut Make and Trim or Tailor) spread in Sukabumi areas. In order for the WIP product can be distributed quickly then needed an efficient distribution channel from the village to Purabaya respectively 13 CMT. Therefore the shortest path or route and the time chosen to optimize the distribution of WIP product, because they have to consider the time that will be spent in the way by looking at the area road conditions. View of the problem in the shortest route search can be used the Travelling Salesman Problem (TSP). TSP is a problem to optimizing and finding travel (tour) the shortest length [6]. TSP is a problem to determine the sequence of all the city has to be visited by the salesman and the city should only be visited exactly one route. The problem of how the salesmen can arrange a trip route, so long he is the optimum route i.e. minimum distance is best [5].Constraints that occur in the field showed the need for the determination of the optimal route with minimum mileage which pay attention to the capacity of the vehicle used by one of the model approach of the Travelling Salesman Problem (TSP) Cheapest Insertion Heuristics Algorithm to deliver the optimal solution to the problem of TSP, including on the selection of the route of travel, costs, and time.

2. Methods

2.1. Cheapest Insertion Heuristic Algorithm

Completed undirected edge weighted graph as G = (V, E), whereas V = {v1,…,vn}, and V = {1,…,n}. c_{ij} is represent the length of (i, j) ∈ E. A tour is a cycle in G with n vertices. A partial tour is a pair of parallel edges in G with at most n – 1 vertices. For a partial tour T and a vertex k / ∈ T we define insert (T, k) to be the cycle obtained by deleting an edge (i, j) ∈ T and inserting instead the two edges (i, k) and (k, j).We say that k is inserted into T. We define by c (T, k) the length increase caused by the insertion of k into T, that is c(T, k) = c(insert(T, k)) – c(T). The Cheapest Insertion algorithm is useful in traveling salesman problem and known as heuristic methods. In our version, the initial partial tour is a minimum cost 2-edge cycle. Alternatively, it could start with an arbitrary vertex as the initial partial tour. For a partial tour T and a vertex k ∈ T we define delete (T, k) to be the cycle obtained by deleting from T the two edges incident with k, say (i, k) and (k, j), and replacing them by (i, j). We say that k is deleted from T and mark the resulting subtour by delete (T, k). Thus, deletion is the inverse operation of insertion. We define by c-(T, k) the length reduction caused by the deletion of k from T, that is c-(T, k) = c(T) – c(delete(T, k)).

Input
A weighted graph G= (V,E).
Begin
k, l: arg, min {cij + cji: I, j ∈ V, I ≠ j},
T: = (k,l, k).
while T is a partial tour
    v: = arg min {c(T,k): k ¢ T}.
    T: = insert (T,v).
end while
end *Cheapest Insertion*

The early stages are done in this research is conducting a study of literature by making reference books and journals that have a relation to the Travelling Salesman Problem (TSP) Cheapest Insertion Heuristics Algorithm. And referring to previous research that is "Enhancing Competitiveness of Ready Made Garment Small-Medium Enterprises Through Logistics Performance Measurement Using SCOR Method" compiled by [2].

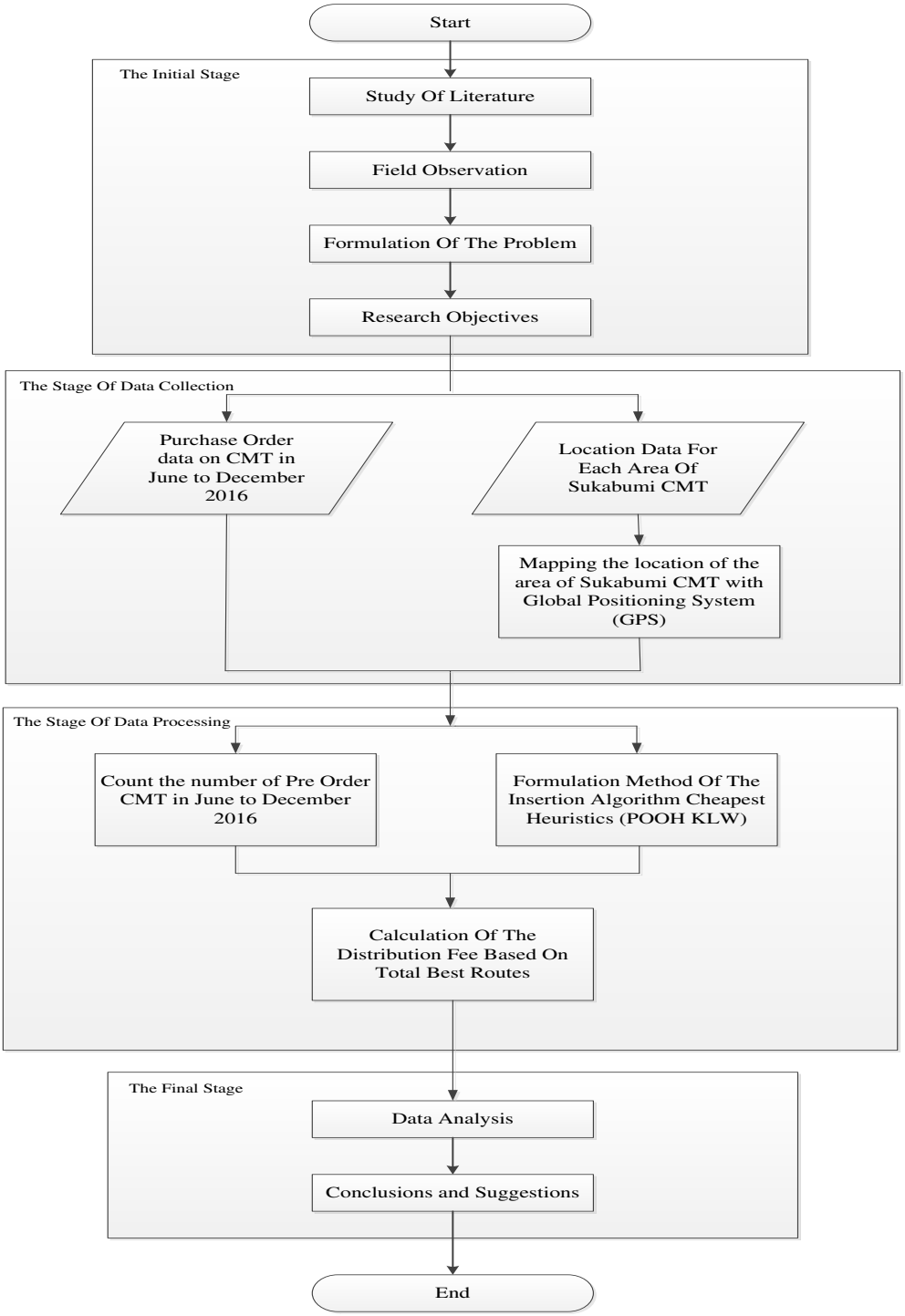

Figure 1. Flowchart Research

The second step is the observation field which aims to select the appropriate location to conduct research. This research was conducted at SME FBS Depot located in the village of Purabaya, Sukabumi-Jawa Barat and CMT are scattered in 13 villages. The third step is to choose a problem researchers review distribution of intermediate goods SME FBS to figure out the optimal distribution channel. The fourth step is to assign the research objectives based on the basic theory of the concept of Cheapest Insertion Heuristics Algorithm. The next step is the collection of data, the data that is

collected in the form of primary data and secondary data. Primary data is data obtained directly from observations of researchers such as company history, a list of operational data, purchase order distribution of intermediate goods in June to December 2016, each location data in CMT The region of Sukabumi, mapping the location of CMT in Sukabumi area with GPS. The next step is data processing that is calculate the number of purchase order cmt from June to December 2016, formulation of CIH Algorithm Method, and last step is analysis, conclusion, and suggestion.

3. Result and discussion

3.1 Operational Data of SME FBS Distribution

The distribution of raw materials in the form of semi-finished goods is done from the warehouse or the center of SME FBS uction located at Jl. Z number 1, South Sukabumi, South Jakarta, and the materials will be sent to Depot SME FBS located in Purabaya Village, Sukabumi. The operational activities of the distribution of SME FBS from Jakarta to Sukabumi are conducted every Friday, starting at 23.00 pm with travel time for ± 5 hours and 12 minutes until Purabaya Village, Sukabumi on Saturday at 04:15 pm. Currently the 13 CMT (tailors) take the semi-finished goods directly to the collecting office in Purabaya Village, Sukabumi. Figure 1 is the distribution route of semi-finished goods in Sukabumi area.

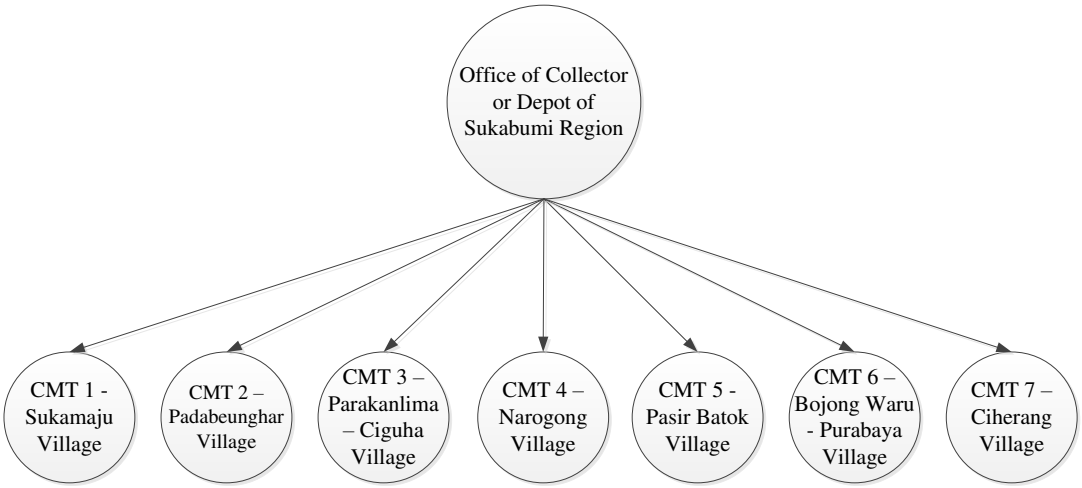

Figure 2. The Distribution Route of Semi-Finished Product in Sukabumi

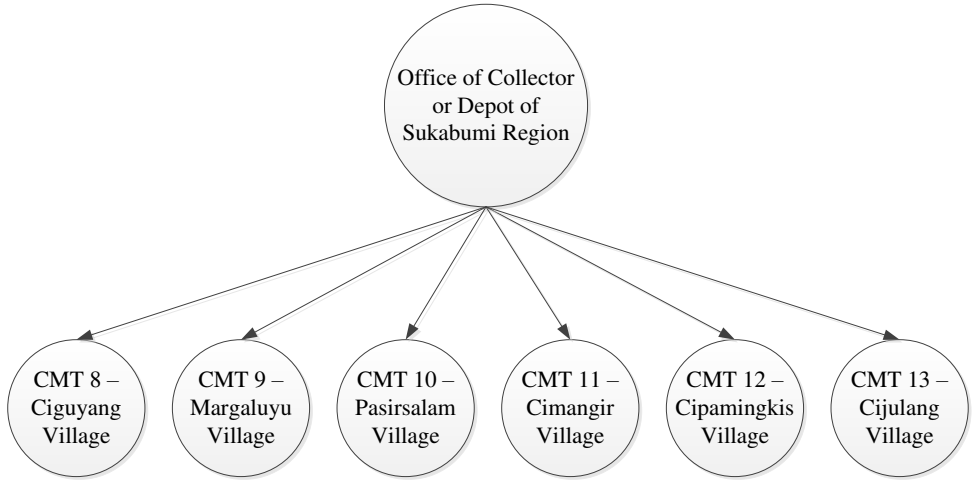

Figure 2. The Distribution Route of Semi-Finished Product in Sukabumi (continue)

It can be seen from Figure 2 that each CMT is scattered in different regions and distance. Table 1 data for the distance and the time taken by each of the CMT to the location of the Depot SME FBS Sukabumi.

Table 1. Number of PO in each CMT from June to December 2016 in Sukabumi

No.	Name CMT	The number of requests (pcs)							
		Jun	Jul	Agst	Sept	Okt	Nov	Des	Total
1	CMT 1	0	0	0	486	0	480	0	966
2	CMT 2	0	0	1476	2058	771	894	972	6171
3	CMT 3	0	0	672	732	2520	540	546	5010
4	CMT 4	0	0	3252	1668	4020	2478	4629	16047
5	CMT 5	0	0	564	1698	0	984	1260	4506
6	CMT 6	0	0	0	0	540	4668	6018	11226
7	CMT 7	0	0	0	0	0	480	1020	1500
8	CMT 8	0	0	384	480	972	3480	2157	7473
9	CMT 9	0	0	0	486	0	0	0	486
10	CMT 10	0	0	720	1128	1224	0	0	3072
11	CMT 11	0	0	0	0	0	0	0	0
12	CMT 12	0	0	0	0	0	0	0	0
13	CMT 13	0	0	0	0	0	0	0	0

In Table 1, it can be seen that each CMT can complete different POs every month from June to December 2016. And for the CMT that does not do the sewing or the total is zero (0), then the data and CMT is not used to process the next data.

Table 2. Data of Distance and Time of CMT to Depot SME FBS

No.	Name CMT	The Name of The Village	The Point Coordinates	Travel Activities	Travel Distance (km)	Total Trip Distance (km)	It takes 1 x Travel	Total Travel Time Travel
0	Depot IKM FBS Sukabumi		-7.100231, 106.890475	-	-	-	-	-
1	CMT 1	Sukamaju	-6.831008, 106.939914	2	52.2	104.4	2 hours 3 minutes	4 hours 6 minutes
2	CMT 2	Padabeunghar	-7.013959, 106.786794	2	24.6	49.2	1 hours 3 minutes	2 hours 6 minutes
3	CMT 3	Parakanlima - Ciguha	-6.996134, 106.826723	2	31.7	63.4	1 hours 26 minutes	2 hours 52 minutes
4	CMT 4	Narogong	-7.006560, 106.837744	2	34.2	68.4	1 hours 35 minutes	3 hours 10 minutes
5	CMT 5	Pasir Batok	-6.805060, 106.704736	2	69.6	139.2	2 hours 37 minutes	5 hours 14 minutes
6	CMT 6	Bojong Waru - Purabaya	-7.098825, 106.888350	2	0.25	0.5	3 minutes	6 minutes
7	CMT 7	Ciherang - Sagaranten	-7.179652, 106.860263	2	17	34	42 minutes	1 hours 24 minutes
8	CMT 8	Ciguyang - Sagaranten	-7.193913, 106.876841	2	14.5	29	33 minutes	1 hours 6 minutes
9	CMT 9	Margaluyu - Cicurug	-6.877141, 106.991827	2	47.9	95.8	1 hours 50 minutes	3 hours 40 minutes
10	CMT 10	Pasirsalam - Nyalindung	-7.346611, 106.661676	2	87.6	175.2	2 hours 57 minutes	5 hours 54 minutes
TOTAL					379.55	759.1		29 hours 38 minutes

Table 2 is the distance and travel time data of CMT to Sukabumi collecting office, in which each CMT has different travel distance and time. The coordinate point uses GPS (Global Positioning System) coordinates with the help of Google Maps application. The next is the required fuel data and costs incurred by each CMT.

In Table 3, it can be seen the total cost incurred to travel from each CMT area to the collecting office in Purabaya-Sukabumi as much as IDR 497.211.

Table 3. Fuel Required and Cost Borne by Each CMT

No.	Name CMT	The Name of The Village	Titik Koordinat	Travel Distance (km)	Fuel Type Premium Required (Litres)	Costs Incurred (1 Trip)		Total Costs Incurred (2 Trips)	
0	Depot IKM FBS Sukabumi		-7.100231, 106.890475	-	-	-		-	
1	CMT 1	Sukamaju	-6.831008, 106.939914	52.2	5.22	IDR	34,191	IDR	68,382
2	CMT 2	Padabeunghar	-7.013959, 106.786794	24.6	2.46	IDR	16,113	IDR	32,226
3	CMT 3	Parakanlima - Ciguha	-6.996134, 106.826723	31.7	3.17	IDR	20,764	IDR	41,527
4	CMT 4	Narogong	-7.006560, 106.837744	34.2	3.42	IDR	22,401	IDR	44,802
5	CMT 5	Pasir Batok	-6.805060, 106.704736	69.6	6.96	IDR	45,588	IDR	91,176
6	CMT 6	Bojong Waru - Purabaya	-7.098825, 106.888350	0.25	0.025	IDR	164	IDR	328
7	CMT 7	Ciherang - Sagaranten	-7.179652, 106.860263	17	1.7	IDR	11,135	IDR	22,270
8	CMT 8	Ciguyang - Sagaranten	-7.193913, 106.876841	14.5	1.45	IDR	9,498	IDR	18,995
9	CMT 9	Margaluyu - Cicurug	-6.877141, 106.991827	47.9	4.79	IDR	31,375	IDR	62,749
10	CMT 10	Pasirsalam - Nyalindung	-7.346611, 106.661676	87.6	8.76	IDR	57,378	IDR	114,756
TOTAL								IDR	497,211

3.2. Delivery Calculation of Semi-Finished Goods

It is illustrated with 11x11 distance matrix table where the M_{ij} element is the distance from *I* to *j*. The table is described in Table 4 as follows:

Table 4. Distance Matrix

	Depot SME FBS Sukabumi	CMT 1 "Sukamaju"	CMT 2 "Padabeunghar"	CMT 3 "Parakanlima - Ciguha"	CMT 4 "Narogong"	CMT 5 "Pasir Batok"	CMT 6 "Bojong Waru - Purabaya"	CMT 7 "Ciherang - Sagaranten"	CMT 8 "Ciguyang - Sagaranten"	CMT 9 "Margaluyu - Cicurug"	CMT 10 "Pasirsalam - Nyalindung"
From / To	0	1	2	3	4	5	6	7	8	9	10
0		52.2	24.6	31.7	34.2	69.6	0.25	17	14.5	47.9	87.6
1	52.2		36.4	28.3	28.8	38.9	52.2	66.6	64.1	25.8	130
2	24.6	36.4		8.8	11.3	40.9	24.8	34.6	32.1	36.4	69.9
3	31.7	28.3	8.8		2.6	37.8	32	41.7	39.2	27	77
4	34.2	28.8	11.3	2.6		38.7	34.4	44.2	41.7	27.5	79.5
5	69.6	38.9	40.9	37.8	38.7		69.6	84	81.5	49.1	106
6	0.25	52.2	24.8	32	34.4	69.6		17.3	14.8	48.1	87.8
7	17	66.6	34.6	41.7	44.2	84	17.3		5.6	60	76.1
8	14.5	64.1	32.1	39.2	41.7	81.5	14.8	5.6		57.5	74.1
9	47.9	25.8	36.4	27	27.5	49.1	48.1	60	57.5		104
10	87.6	130	69.9	77	79.5	106	87.8	76.1	74.1	104	

3.3. Calculation of Optimal Route Using Cheapest Insertion Heuristics Algorithm Method for TSP

Step 1: Search is started from the first city linked to the last city.
The data processing in the first step is taken from area or region 0 to 10.

Step 2: Creating a subtour relationship between the two cities.
Data processing of the second step makes the subtour: (0,10) → (10,0)

Step 3: Creating a table that stores the city that can be inserted in the subtour along with the additional distance. The added point is the point that has never been passed, which is shown in Table 5

From Table 5, it can be seen the smallest temporary insert is 0.45 kilometers using the formula at (1):

$$C_{ik} + C_{kj} - C_{ij} = (0{,}25 + 87{,}8) - 87{,}6 \quad (1)$$
$$= 0{,}45$$

Table 5. Arc Addition of Subtour to 1

The Arc Will be Replaced	The Arc To be Added	The Extra Distance
(0,10)	(0,1) - (1,10)	94.6
(0,10)	(0,2) - (2,10)	6.9
(0,10)	(0,3) - (3,10)	21.1
(0,10)	(0,4) - (4,10)	26.1
(0,10)	(0,5) -(5,10)	88
(0,10)	(0,6) - (6,10)	0.45
(0,10)	(0,7) - (7,10)	5.5
(0,10)	(0,8) - (8,10)	1
(0,10)	(0,9) - (9,10)	64.3
(10,0)	(10,1) - (1,0)	94.6
(10,0)	(10,2) - (2,0)	6.9
(10,0)	(10,3) - (3,0)	21.1
(10,0)	(10,4) - (4,0)	26.1
(10,0)	(10,5) - (5,0)	88
(10,0)	(10,6) - (6,0)	0.45
(10,0)	(10,7) - (7,0)	5.5
(10,0)	(10,8) - (8,0)	1
(10,0)	(10,9) - (9,0)	64.3

Arc (0,10) is replaced with *Arc* (0,6) and *Arc* (6,10) or *Arc* (10,0) is replaced with *Arc* (10,6) and *Arc* (6,0). If there are 2 routes that have the same total distance, one can be choosen. For example the first possibility is chosen, then the new subtour becomes: (0,6) → (6,10) → (10,0).

Step 4: Next is a table that stores the biased area or region is inserted in subtour along with the additional distance
The smallest additional distance is 29.05 kilometers by using the formula at (1) which replaces *Arc* (0,6) with *Arc* (0,8) and *Arc* (8,6), so the new subtour produced is: (0,8) → (8,6) → (6,10) → (10,0).

Step 5: Because there are villages that still have not yet been logged in, it is necessary to create a table storing cities that can be inserted in the subtour along with the additional distance
The smallest additional distance is 8.1 kilometers by using the formula at (1) which replaces *Arc* (0,8) with *Arc* (0,7) and *Arc* (7,8), so the new subtour produced is: (0,7) → (7,8) → (8,6) → (6,10) → (10,0).

Step 6: Because there are villages that still have not been entered, then a table is created to store villages that can be inserted in the subtour along with the additional distance
The smallest additional distance is 42.2 kilometers by using the formula at (1) which replaces *Arc* (0,7) with *Arc* (0,2) and *Arc* (2,7), so the new subtour produced is: (0,2) → (2,7) → (7,8) → (8,6) → (6,10) → (10,0).

Step 7: Because there are villages that still have not yet entered, then the table will be created to store villages that can be inserted in the subtour along with the additional distance
The smallest additional distance is 15.9 kilometers by using the formula at (1) which replaces *Arc* (0,2) with *Arc* (0,3) and *Arc* (3,2), so the new subtour produced is: (0,3) → (3,2) → (2,7) → (7,8) → (8,6) → (6,10) → (10,0).

Step 8: By looking at villages that have not yet entered the subtour, then a table is created to store the village that can be inserted in the subtour along with the additional distance
The smallest additional distance is 5.1 kilometers by using the formula at (1) which replaces *Arc* (0,3) with *Arc* (0,4) and *Arc* (4,3), so the new subtour produced is: (0,4) → (4,3) → (3,2) → (2,7) → (7,8) → (8,6) → (6,10) → (10,0).

Step 9: Since there are villages that still have not yet been logged in, the table is then rebuilt to store the village that can be inserted in the subtour along with the additional distance
The smallest additional distance is 41.2 kilometers by using the formula at (1) which replaces *Arc* (0,4) with *Arc* (0,9) and *Arc* (9,4), so the new subtour produced is: (0,9) → (9,4) → (4,3)→ (3,2) → (2,7) → (7,8) → (8,6) → (6,10) → (10,0).

Step 10: Because there are villages that still have not been entered, then a table is created to store the village that can be inserted in the subtour along with the additional distance
The smallest additional distance is 30.1 kilometers by using the formula at (1) which replaces *Ar* (0,9) with *Arc* (0,1) and *Arc* (1,9), so the new subtour produced is: (0,1) → (1,9) → (9,4) → (4,3)→ (3,2) → (2,7) → (7,8) → (8,6) → (6,10) → (10,0).

Step 11: Then the table is rebuilt to hold the village that can be inserted in the subtour along with the additional distance
The smallest additional distance obtained is 56,3 kilometers using the formula at (1) which replaces *Arc* (0,1) with *Arc* (0,5) and *Arc* (5,1), so the new subtour is: (0,5) → (5,1) → (1,9) → (9,4) → (4,3)→ (3,2) → (2,7) → (7,8) → (8,6) → (6,10) → (10,0).

It can be concluded that from all the above steps and the additional subtour, the optimal route calculation which can be passed in the distribution of semi-finished product in SME FBS which is the shortest route for 10 villages is (0,5) → (5,1) → (1,9) → (9,4) → (4,3)→ (3,2) → (2,7) → (7,8) → (8,6) → (6,10) → (10,0) that can be seen in figure 2.

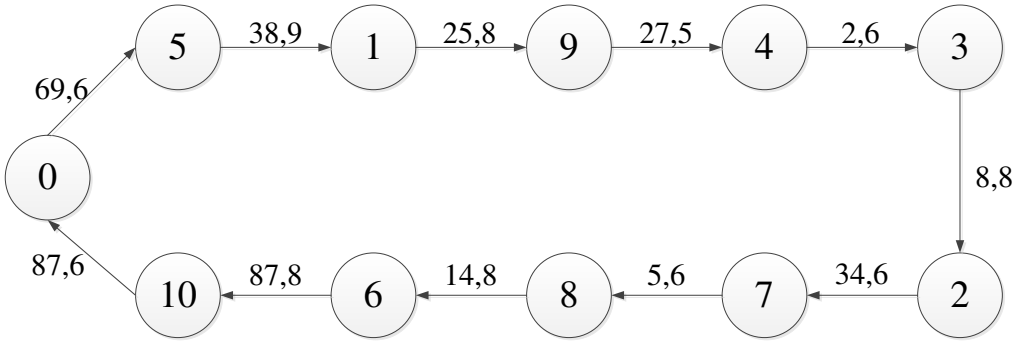

Figure 3. Trajectory or Shortest Route among 10 Villages at Each CMT of SME FBS in Sukabumi Region

Figure 3 is resulted from the trajectory or the shortest route for the distribution of semi-finished materials that will be distributed to each of the 10 CMT on SME FBS in Sukabumi Region. This trajectory or route is acquired the mileage which is $C_{0,5} + C_{5,1} + C_{1,9} + C_{9,4} + C_{4,3} + C_{3,2} + C_{2,7} + C_{7,8} + C_{8,6} + C_{6,10} + C_{10,0}$ = 403,6 km starting from 0-5-1-9-4-3-2-7-8-6-10-0. with the following explanation Depot SME FBS Sukabumi - Pasir Batok Village – Sukamaju Village –Margaluyu, Cicurug Village – Narogong Village – Parakanlima, Cuguha Village – Padabeunghar Village – Ciherang, Sagaranten Village – Ciguyang, Sagaranten Village – Bojong Waru, Purabaya Village – Pasirsalam, Nyalindung Village – then back again to the Depot SME FBS Sukabumi.

Time that must be traveled to do the distribution of intermediate goods starting from Depot SME FBS Sukabumi and back again to the Depot SME FBS Sukabumi using a mode of transportation owned SME FBS "Mitsubishi Colt L300" and Trucks Engkel Box "110ps Diesel Mitsubishi Colt" with a speed of 40 km/hours due to view the road conditions in the area of Sukabumi, here is the time needed to perform the pendisribusian intermediate goods:

$$t = \frac{s}{v} = \frac{403{,}6\ km}{40\ km/hours} = 10\ hours\ 09\ minutes \quad (2)$$

Obtained results it takes to do the distributing intermediate goods for 10 hours 9 minutes.

Obtained information that in previous distribution where CMT come straight to Depot SME FBS Sukabumi takes time for 29 hours 38 minutes with a total distance traveled 759.1 km, while route optimization is done only after the takes 10 hours 09 minutes total distance traveled 403.6 kilometers. Using the distribution route optimization done every once a week be exact on Saturday by sending just one time only. The results can be seen from the comparison between the old distribution system with the best route proposal by using Cheapest Insertion Heuristics Algorithm Method retrieved the level of efficiency of approximately 47%.

3.4. Cost Calculation Based on Best Total Route

Mileage in route delivery of transportation costs. In this case the cost of transportation efficiency calculation is done using the efficiency of distance traveled, which can reach a distance of 403.6 km correspond to the optimal route calculation.

SME FBS has 2 types of vehicles that is "Mitsubishi Colt L300" with 2477 cc engine with a maximum capacity of 2.5 tons, while for the type of Engkel Box Truck Box "Colt Diesel 110ps Mitsubishi" with 3908 cc engine with a maximum capacity of 2 tons, from 2 types the vehicle is a fuel in use is diesel in which 1 litre of gasoline type diesel can travel ± 7 km [3]. And the cost of fuel for the type of diesel costs Rp 5.150/litre [3]. And see the road condition of the region sukabumi car can run with speed 40 km/hour. From the following calculation results obtained to do the distribution to 10 CMT region as follows:

1 Litre of Solar Fuel = Rp. 5.150
1 Litre of Solar Fuel can travel = ± 7 km
Then,
We get

$$1\ km = \frac{IDR\ 5.150}{7\ km} = IDR\ 735{,}7\ /km$$

$$BFuel\ needed\ = \frac{403{,}6\ km}{7\ km} = 57{,}66\ Litre$$

So obtained

$C_{the\ efficiency\ of\ the}$ = *(The cost of Gasoline for one kilometer) x* ($d_{e\ the\ efficiency\ of\ the}$) (3)

= IDR 735,7 /km x 403,6 km = IDR 296.928,52 /once delivered

Judging from the results obtained to distribute goods to half so to 10 CMT in Sukabumi Region by using vehicle types "Mitsubishi Colt L300 Engkel Box Truck" and "Colt Mitsubishi 110ps Diesel" takes over 10 hours, 10 minutes, in addition the materials needed for ingredients amounted to 57.66 litres and costs that must be incurred to buy fuel at IDR 296,928.52 that distinguish only capacity.

It can be seen that the cost that must be issued before the route optimization of IDR 497,210.50 while the cost that must be issued after the route optimization of IDR 296,928.52 can efficient a fee of 40% in 1 trip. Moreover, it can be seen from these two types of vehicles have similar results to do the distribution of intermediate goods to 10 CMT in Sukabumi Region in both the time taken, the fuel that is needed, and the cost to purchase the materials burn that sets it apart is the maximum capacity of each type of vehicle.

4. Conclusion

Based on the calculation concerning the shortest proposed route to distribute the semi-finished products in SME FBS to the 10 villages in Sukabumi by using Cheapest Insertion Heuristics (CIH) algorithm for the completion of the Traveling Salesman Problem (TSP) and cost efficiency inreference to the best route, it can be summarized as follows:

1. The shortest route from the calculation is 1-6-2-10-5-4-3-8-9-7-11 with the distance of 403,6 kilometers, with the following explanation: Depot SME FBS Sukabumi - Pasir Batok Village –

Sukamaju Village –Margaluyu, Cicurug Village – Narogong Village – Parakanlima, Cuguha Village – Padabeunghar Village – Ciherang, Sagaranten Village – Ciguyang, Sagaranten Village – Bojong Waru, Purabaya Village – Pasirsalam, Nyalindung Village – then back again to the Depot SME FBS Sukabumi with the distance efficiency level of 47% in 1 time travel and done every once a week on Saturday.

2. The distribution of Costs issued by SME FBS after route optimization done IDR 296,928.52 whereas before the optimization of IDR 497,211 to the level of cost efficiency of 40% in 1 trip.

5. References

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