

Determination Of Distribution Center Location In Xyz Small And Medium Enterprise (Sme) Using Center Of Gravity Method

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Abstract: XYZ Small Medium Enterprise (SME) is an SME that produces hijab. Research activities on XYZ aims to determine the operational cost of XYZ, caused by the far distance between the production site with retails. The analytical method which we use is by using the Center of Gravity. From the results of using the Center of Gravity method, the location of the new warehouse can be determined with the coordinates $X = -7.51$, $Y = 110.45$, which is located in Dusun II, Lencoh, Selo, Boyolali Regency, Central Java, XYZ can save distribution operational cost from IDR 22,711,150 to IDR 12,712,400. Therefore, XYZ can save distribution operational costs of IDR 9,998,750 or with a percentage of 55.97%. With the new distribution center location, it will shorten the distance from 1446 km to 264.6 km and reduce the transportation cost from the production site in Cicalengka, Bandung to the distribution center located in Dusun II, Lencoh, Selo, Boyolali Regency, Central Java.

Keywords : Distribution Center, Center of Gravity, Distribution, Small Medium Enterprise.

1. Introduction

Logistics is about planning and controlling the flow of material and information in an organization in both public and private sectors (Ghani, Laporte, & Musmanno, 2004). Distribution is the activity of delivering products from producers to consumers as end users (Kotler, Saliba, & Bruce, 1991; Antoni et al., 2019). Distribution activities are important in manufacturing to create an integrated system from a single location point to another location point. The farther the distance distribution activities will cause more cost. This is certainly contrary to the principle of business which is to get the maximum profit with minimum expenditure. To make efforts to deliver products according to demand with the right route, fast time, and minimum cost, one of the concerns is operational costs.

Operational cost is a definitive cost in every manufacture, both manufacture-based companies and service-based companies, also as an indicator to determine if a company is operating well or not. Therefore, it needs a location facility to reduce the operational cost as minimum as possible. One of the SMEs in the Rancaekek area - West Java also experienced the problem of distribution costs increases. XYZ SMEs has market share in several cities in Central Java, the distance between production houses and retail shops is quite far resulting in high distribution costs. XYZ need a facility that is able to reduce distribution costs in order to maximize sales profits both in terms of costs and fulfillment of customer needs and satisfaction. In Facilities Planning book which published by John Willey & Sons, Inc., mentioned that facility is a critical component of a graded global network which needed for supply chains superiority.

2. Literature review

Product distribution from manufacture to customer (Pujawan, 2010):

1. Direct Shipment

In this model, the shipment is directly delivered from the manufacture to customer without warehouse or any supporting facilities. This strategy is suitable for goods with low durability and goods that easily to be damaged in loading process.

2. Warehouse Shipment

In this model, goods aren't delivered directly to customers, but through one or more warehouses or supporting facilities. This model is suitable for products that have uncertain demand or supply, and products that have a relatively strong durability.

3. Cross Docking

In this model, the pickup and delivery transportation will meet in the cross-dock facility which located between the manufacture and the customers. In this model, the goods are directly transported at different locations so that shippers can be relatively faster and still can achieve good transportation savings due to their existence. this strategy is weak in terms of needs.

According to Dwiningsih (2002; Bello & Steyn, 2019; Maluleke & Dlamini, 2019; Akbas et al., 2019; Ay & Zeynep, 2019; Adell et al., 2019; Fuentes et al., 2019; Aydin et al., 2019), Center of Gravity Method is a mathematical technique to determine the ideal location for a certain single distribution point that serve several store or regions. This method calculates the market distance, the amount of shipped goods, and shipment cost.

The step to use the Center of Gravity is explained below:

1. Determine the goods quantity that shipped from the manufacture site to the warehouse site (which will be searched) in each period.
2. Open a map, determine a certain location as the origin point (0,0).
3. Place the market location on the coordinate system with origin point as its base.
4. Determine the distribution warehouse coordinate by this formula:

$$\text{Coordinate } x \text{ CoG } (Cx) = \frac{\sum dix Qi}{\sum Qi}$$
$$\text{Coordinate } y \text{ CoG } (Cy) = \frac{\sum diy Qi}{\sum Qi}$$

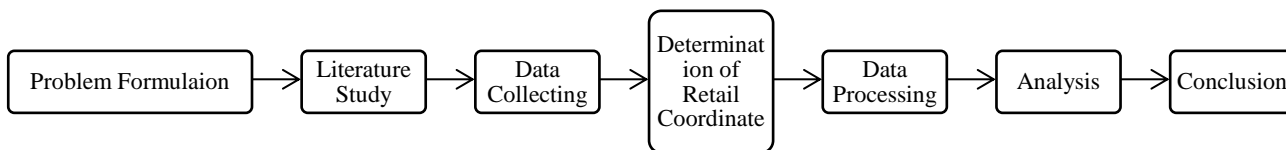
Explain:

dix = x coordinate point i

diy = y coordinate point i

Qi = Goods quantity that shipped to or from point i

3. Methods



1. Determine the problem formulation from the determination of retail coordinate research.
2. Literature study to collecting various theory and literature which help the research process to be the base research.
3. Data collecting that this research use is the data collected from a hijab SME at Rancaekek, Bandung. The data contains shipment cost, quantity of the shipped goods, and shipment location.
4. Determination of Retail Coordinate found by SME location data and consumer location data processed and plotted by using Google Maps application to obtain the coordinate point from each location. The research method implemented by observation and direct data collecting from XYZ SME.
5. Data processing in this research conducted by using the CoG method based on the theoretical basis. Beside the SME location data and the consumer coordinate point, the authors also using secondary data which are demand data from each customer, and the cost of single goods shipment from manufacture to consumer. The data result will be determined according to variables that needed in this research, which included shipment cost, and customer demand.
6. Authors conduct the analysis from data result obtained in a form of comparison between operational cost with or without Distribution Center.
7. The research conclusion used to answer the research purpose.

4. Results and discussions

The research data from XYZ SME are obtained from location and product demand quantity of four retails in Central Java. The distribution activity conducted by one month period in each retail and conducted on different days.

Calculation of distribution cost from manufacture site to each retail

a. Purworejo (Pasar Baledono)

Distances : 313 km
 Coordinate Point : -7.7097596838276985, 110.0198853976403
 Additional Costs : IDR 250,000
 Courier Fee : IDR 1,400,000 / 2 persons (Driver and Helper)
 Transport Costs : IDR 2,660,500
 Fuel Costs : IDR 406,350 (for ± 63 liters of gasoline)
 Total : IDR 4,716,850

b. Yogyakarta (Pasar Beringharjo)

Distances : 369 km
 Coordinate Point : -7.798575073334949, 110.3659937797508
 Additional Costs : IDR 250,000
 Courier Fee : IDR 1,500,000 / 2 persons (Driver and Helper)
 Transport Costs : IDR 3,136,500
 Fuel Costs : IDR 477,300 (for ± 74 liters of gasoline)
 Total : IDR 5,363,800

c. Solo (Pasar Klewer)

Distances : 441 km
 Coordinate Point : -7.576215856936245, 110.82766896612269
 Additional Costs : IDR 250,000
 Toll Costs : IDR 484,000 (Kertajati-Solo Toll Road)
 Couriers Fee : IDR 2,000,000 / 2 persons (Driver and Helper)
 Transport Costs : IDR 3,748,500
 Fuel Costs : IDR 580,500 (for ± 90 liters of gasoline)
 Total : IDR 7,063,000

d. Semarang (Pasar Johar)

Distances : 343 km
 Coordinate Point : -6.970608219988645, 110.43014052153019
 Additional Costs : IDR 250,000
 Toll Costs : IDR 250,500 (Kertajati-Solo Toll Road)
 Couriers Fee : IDR 1,700,000 / 2 persons (Driver and Helper)

Transport Costs : IDR 2,915,500
Fuel Costs : IDR 451,500 (for \pm 70 liters of gasoline)
Total : IDR 5,567,500

The total distribution costs from the manufacture site to each retailer sites is IDR 22,711,150

Table 1 Coordinate Point and Each Retail Transportation Cost

Retail Location	Coordinate Point		Transportation Costs (Qi)
	x (dix)	y (diy)	
Purworejo	-7,71	110,02	IDR 4,716,850
Yogyakarta	-7,80	110,37	IDR 5,363,800
Solo	-7,58	110,83	IDR 7,063,000
Semarang	-6,97	110,43	IDR 5,567,500
Total			IDR 22,711,150

To obtain the $dixWi$ and $diyWi$ coordinate points, coordinate points (x,y) in each retail multiplied by each retail transportation cost. Therefore, the result obtained are as follows:

Table 2 Center of Gravity Calculation

Retail Location	Coordinate Point		Transportation Costs (Wi)	Coordinate Point	
	x (dix)	y (diy)		x (dix.Wi)	y (diy.Wi)
Purworejo	-7,71	110,02	IDR 4,716,850	-36365779,96	518947296,4
Yogyakarta	-7,80	110,37	IDR 5,363,800	-41829996,98	591981117,4
Solo	-7,58	110,83	IDR 7,063,000	-53510812,6	782775825,9
Semarang	-6,97	110,43	IDR 5,567,500	-38808861,26	614819807,4
Total			IDR 22,711,150	-170515450,8	2508524047,1

After the value of $\sum Qi$, $\sum dixQi$, and $\sum diyQi$ are obtained, input those value into the formula to determine the new Distribution Center coordinate point.

$$Cx = \frac{\sum dixQi}{\sum Qi} \qquad Cy = \frac{\sum diyQi}{\sum Qi}$$

$$Cx = \frac{-170.515.450,8}{22.711.150} \qquad Cy = \frac{2.775.156.996,8}{25.166.950}$$

$$Cx = -7,51 \qquad Cy = 110,45$$

New Distribution Center coordinate point is (-7.51, 110,45)

Calculation of distribution cost from new distribution center site to each retail

a. Purworejo (Pasar Baledono)

- Coordinate Point : -7.7097596838276985, 110.0198853976403
- Distances : 74,8 km
- Additional Costs : IDR 250,000
- Couriers Fee : IDR 1,000,000 / 2 persons (Driver and Helper)
- Transportation Costs : IDR 635,800
- Bensin : IDR 96,750 (for ± 15 liters of gasoline)
- Total : IDR 1,982,550

b. Yogyakarta (Pasar Beringharjo)

- Coordinate Point : -7.798575073334949, 110.3659937797508
- Distances : 55 km
- Additional Costs : IDR 250,000
- Couriers Fee : IDR 1,000,000,- / 2 persons (Driver and Helper)
- Transportation Costs : IDR 467,500
- Bensin : IDR 70,950 (for ± 11 liters of gasoline)
- Total : IDR 1,788,450

c. Solo (Pasar Klewer)

- Coordinate Point : -7.576215856936245, 110.82766896612269
- Distances : 48 km
- Additional Costs : IDR 250,000
- Couriers Fee : IDR 1,000,000 / 2 persons (Driver and Helper)
- Transportation Costs : IDR 408.000
- Bensin : IDR 64,500 (for ± 10 liters of gasoline)
- Total : IDR 1,722,500

d. Semarang (Pasar Johar)

- Coordinate Point : -6.970608219988645, 110.43014052153019
- Distances : 86,8 km
- Additional Costs : IDR 250,000
- Biaya Tol : IDR 25,500 (Salatiga-Semarang Toll Road)
- Couriers Fee : IDR 1,000,000 / 2 persons (Driver and Helper)

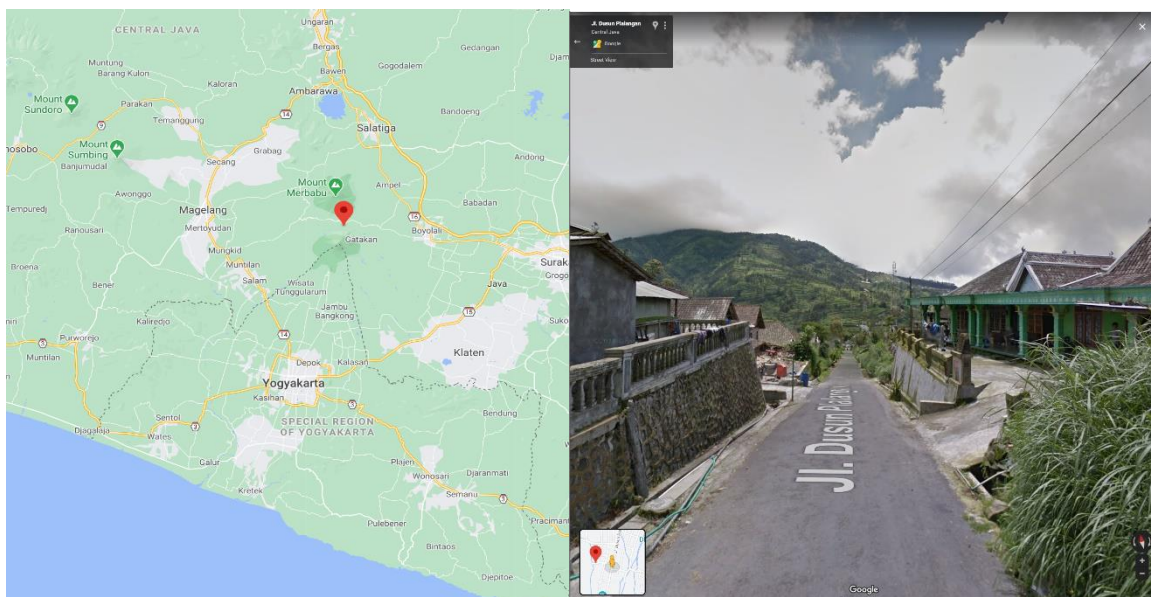
- Transportation Costs : IDR 737,800
- Bensin : IDR 116,100 (for ± 18 liters of gasoline)
- Total : IDR 2,129,400
- e. From manufacture site to new distribution center site
- Coordinate Point : -7.43, 110.27
- Distances : 391 km
- Additional Costs : IDR 250,000
- Couriers Fee : IDR 1,000,000 / 2 persons (Driver and Helper)
- Transportation Costs : IDR 3,323,500
- Bensin : IDR 516,000
- Total : IDR 5,089,500

The total of distribution cost from Distribution Center to each retail plus shipment cost from manufacture site to distribution center is IDR 12.935.750. Center of Gravity affects the distribution cost and the distribution distance. The table below is the comparison between total distribution distance from manufacture site to retails and total distribution distance from *Distribution Center* to retails.

Tabel 3 Comparison of Distribution Distances

Comparison of Distribution Distances			
No	Retail Location	From Manufacture Site	From Distribution Center Site
1	Purworejo	313 Km	74,8 Km
2	Yogyakarta	369 Km	55 Km
3	Solo	441 Km	48 Km
4	Semarang	343 Km	86,8 Km
Total		1466 Km	264,6 Km

Based on the CoG calculation, the new coordinate point is located at (-7.51, 110.45). The coordinate point is located on the region of Dusun II, Lencoh, Selo, Boyolali Regency, Central Java 57363



Picture 1 New Distribution Center Location (Left), The Environment of New Distribution Center Location (Right)

(Source: Google Maps)

The following table is comparison between distribution cost from manufacture site to each retail with Distribution Center to each retail

Tabel 4 The Comparison of Distribution Costs

Comparison of Distribution Costs to Retails Site			
No	Retail Location	From XYZ's Manufacture Site	From XYZ's Distribution Center Site
1	Purworejo	IDR 4.716.850	IDR 1.775.350
2	Yogyakarta	IDR 5.363.800	IDR 1.777.900
3	Solo	IDR 7.063.000	IDR 2.220.500
4	Semarang	IDR 5.567.500	IDR 2.048.700
Total		IDR 22.711.150	IDR 7.622.900

Table 4 showed a significant difference of distribution cost. The cost from manufacture site (Bandung) to the retails is IDR 22.711.150. Meanwhile the distribution cost from Distribution Center (Magelang) to the retails is IDR 7.622.900, in which the shipment cost in each retail were reduced significantly. The shipment cost from manufacture site to Distribution Center is IDR 5.089.500, so the total distribution cost that required is IDR 12.712.400. Therefore, XYZ can save the budget for distribution cost for IDR 9.998.750. Based on the distance calculation between manufacture site and Distribution Center to the retails, the distance that need to cover if the distribution conducted from manufacture site is 1446 km. Meanwhile if the distribution process conducted form Distribution Center, it only needs to cover 264,4 km. This result showed the Center of Gravity method affecting the distribution distance.

5. Conclusion

1. The location of Distribution Center which obtained by Center of Gravity calculation were located in coordinate point (-7.51, 110.45), which at region of Dusun II, Lencoh, Selo, Boyolali Regency, Central Java.
2. Distribution cost difference between manufacture site and distribution center to the retails occurred with IDR 9,998,750 gap.
3. The use of CoG method affecting the distance covered and the transportation cost. From the cost perspective, shipment cost that conducted from manufacture site requires IDR 22,711,150. Meanwhile the shipment cost from Distribution Center only requires 12,712,400. From distance perspective, the distribution distance from manufacture site needs 1446 km to cover. Meanwhile the distribution distance from Distribution Center only needs 264,6 km to cover.

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