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Optimization of the Determination of the Route with the Approach of Farthest Insert Method

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Abstract: The purpose of the determination of this route is to optimize the number of trucks to minimize costs. The distance and travel time is maximized by determining which truck to be used and which path will be used in delivering the goods to the location of the user enterprise services as well as certain goods does not exceed the load capacity and delivery on time. In this study, only used 15 trucks with a container of 40 feet from a total of 110 vehicles and 43 trailers tronton vehicles owned by the company. Study period from January-October 2013 route is selected from the Port of Tanjung Priok (Jakarta) to 5 goals of service users, i.e., Padalarang (West Bandung), Jatiluhur (Purwakarta), Cileungsi (Bogor), Kerawang and Serang (Banten) using Farthest Insert Method that produces an optimal route than the route used by the company today and with this route can save operating expenses amounted IDR.5,890,050.

Key words: Optimization, route determination, Father Insert Method, forwarding company, export import

INTRODUCTION

Now a days competition among distribution companies is very tight both for capital, the completeness of the types of products sold, customer network that is owned by a company, selling prices, the provision of service to customers, the speed and accuracy to process the incoming orders, shipping orders until the subscription. The distribution companies are now required to be more efficient in using resources economically, considering each step of distribution that can not be separated from the costs to be incurred by the company in an effort to increase sales. It was customary in the business world that companies are trying to maximize long-term profits by considering the risks and uncertainties in order to minimize costs. According to Abdillah and Adib Fahrozi, the main objective of distribution of goods is expanding market share. According to Deshmukh (2012) the size of the cost is very relative, depending on the obstacles encountered during the distribution of goods.

Data of logistics transport industry in Indonesia, according to Frost and Sullivan (2013), grew by 14.5% to IDR. 1,634 trillion in 2013 from last year's estimate of IDR. 1,427 trillion, it is also encouraged by the initiative and the development of the logistics industry by the government as well as string economic growth. Gopal who is the Vice President of Global Transportation and Logistics Practice, revealed that the relocation and strong capital flows are expected to drive the growth of manufacturing and increasing demand for logistics in Indonesia. He added that foreign trade to Indonesia is expected to rise moderately by 16.7% reached $446 billion in the year 2013, all of this background, the core Mandiri Persada Ltd., a company engaged in the transportation forwarding services located in Jakarta (Indonesia) want to know how big the obstacle is going on inside the company as well as the risk in the way during expeditions run and examine the route that is used and how to handle problems that occur in the field expedition to the company's operations more effectively and efficiently and minimize delays.

Problem identification: How Farthest Insert Method can solve the problem of determining the route contained in this company to a delay in delivery can be minimized?

Literature review

Definition of transportation: Transport system is the most important economic activity among the components of the business of logistics systems (Tseng *et al*., 2005). According Chopra and Meindl (2013), the transportation function to move the product between one stage to another stage. Some components of transportation that should be considered include: route selection, the path which must be passed in conducting the transfer of goods, types of transportation whether by air, truck, rail or water while according to Wongso and Sarjono (2013),

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the correct distribution web can be utilized to achieve many types of purpose in supply chain, starting from small cost to high response towards customers high demand. Journal written by Talpur *et al*. (2012), states that the transport is considered as an important part of human life and the national backbone, regional and local economies. The transport sector plays a vital role in raising the lifestyle of the common people by providing the necessary facilities and accessibility to them.

MATERIALS AND METHODS

Methods for determining the route and delivery schedule: After learning the results of the new demand forecast can analyze the distribution initially. In analyzing, the distrubusi the required data which is preliminary data relevant to the problem to be investigated. One of the methods that can be used for the data processing is the savings matrix. Steps those must be done are as follows:

Identify the distance matrix: At this step to know the distance between the warehouse company to each final destination distribution. By knowing the coordinates of each location, the distance between two locations can be calculated. The results of the distance calculation will then be used to determine the savings matrix (matrix savings).

Identify savings matrix (matrix savings): Savings matrix represents savings can be realized by combining the two locations into a single distributed destination route. Savings matrix method (Pujawan, 2010) is a method to minimize the distance or time or expenses taking into account the constraints that exist. Distance is used as the objective function when the final destination is known coordinates the distribution then the distance to be traveled by all vehicles will be minimized.

Allocate consumers in the travel route vehicles: At this stage, the consumer division carried into a vehicle travel route by considering the capacity of consumers and used vehicles. A route is said feasible if the amount of the total demand of all consumers do not exceed the capacity of the vehicle and the amount of demand from the consumers as a whole can be accommodated by a single vehicle. The procedure used for the grouping of consumers that is based on the value of saving the largest matrix. So, first of all sort the saving rate up to the capacity of the largest matrix used vehicles can accommodate all requests. If the capacity is maximal then the procedure will be repeated until all the customers allocated in a way.

Sort pendistribuian final destination in the route that has been defined: This stage is the final stage of the method of saving matrix. The purpose of this stage is the sort of vehicle visits to each consumer who has been grouped in a travel route in order to obtain the minimum distance. Here are some ways that is used for sorting the visit.

Insert farthest: This procedure is done by adding the consumer in a travel route. This procedure starts from the determination of the route of vehicles to consumers who have the farthest distance. Then, this procedure will continue to repeat until all consumers into the travel route.

Insert nearest: This procedure is the reverse of farthest insert procedure which is starts from the determination of the route the vehicle to a consumer who has the closest distance. Then, this procedure will continue to repeat until all consumers into the journey.

Nearest neighbour: The procedure is to start the vehicle from a distance the route closest to the depot. Then, the next route is the consumer that is closest to the first customer who has visited. This procedure will be repeated until all the consumers into the travel route (Fig. 1).

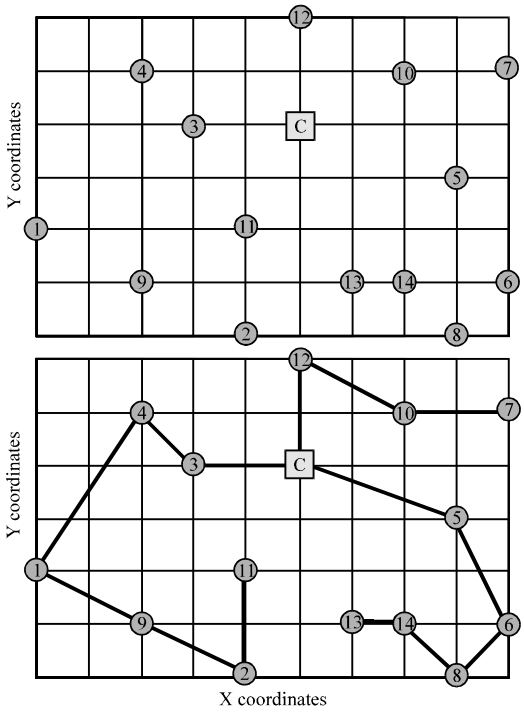

Fig. 1: Route pattern from warehouse (centre)

RESULTS AND DISCUSSION

Research design: The analytical method used was a survey and observation. Data were collected cross-sectional data collection which is only done in one time (Table 1 and 2).

Method of analysis: In the implementation of the activities of this research, the method of analysis used by the procedure saving Farthest Insert Matrix Method (Table 3).

Company profile: Inti Mandiri Persada Ltd. which is located in the Berikat Nusantara, Jl. Bandung Block A1/9, Marunda, North Jakarta is a company engaged in the field of freight forwarding and transportation expedition has been established, since 1993 and took the company sent either export or import of goods through the request of the service user wears container trucks. His request a third party that party of 20, 40 feet and the party of the truck combo that uses two container measuring 20 feet but in this study, only counted 15 truck container of 40 feet. More customers are repeat customers engaged in the export and import of among other things:

Table 1: Research design

Research purpose	Research type	Used method	Unit analysis	Time horizon
T-1	Descriptive	Survey	Delivery department	Cross-sectional

Table 2: Operationalization of research variables

Variables	Concept	Indicator
Route determination (T-1)	Distribution routes or paths that will be done every time you make an activity of delivery to the customer	Saving matrix with the prosedure of Farthest Insert Method

Table 3: Method of analysis

Research purpose	Analysis technique
T-1	Farthest Insert Method

- Ultra Jaya Milk Industry Ltd. (Jl. Cimareme highway, No. 131, Laksanamekar, Padalarang, West Bandung), engaged in the UHT milk
- Indo Rama Synthetics Ltd. (Jl. Industry Ubrug, Kembangkuning, Jatiluhur, Purwakarta), engaged in the export and import of industrial raw materials and polyester textile
- Aspex Kumbong Ltd. (Jl. Narogong km 26, Cileungsi, Bogor), engaged in the material newsprint
- Pindo Deli Pulp and Paper Mills Ltd. (Village Kutamekar BTB6, No. 9, Kerawang, 41361, West Java), engaged in the export and import of industrial raw material of paper
- Indah Kiat Pulp and Paper Mills Ltd. (Jl. Jakarta-Serang highway, km 76, Serang, 42184, Banten), engaged in the export and import of industrial raw material of paper

Preparation of the route with saving matrix method: In determining, the route to deliver orders of Inti Persada Mandiri, Ltd. consumer's demand, the saving matrix method is used. There are several steps in this method to the determination of the route of each vehicle among other things:

Identification of matrix distance: The 1st step is to locate the location of the company and the location of each end of the distribution (in this study 5 customer as the delivery destination is located in Banten, Jakarta, West Java and surrounding areas).

To facilitate solving the problem of determining the route, the delivery objectives plotted into the map with the help of a mapping program, Google Map then the points that have been obtained and made scale X axis Y axis with a point X0 (the location of the Tanjung Priok (Jakarta) which is the starting point of delivery) as the coordinates of the center (0,0) as shown on the map (Fig. 2). Here is the travel distance to a variety of data users enterprise services from the point of coordinates

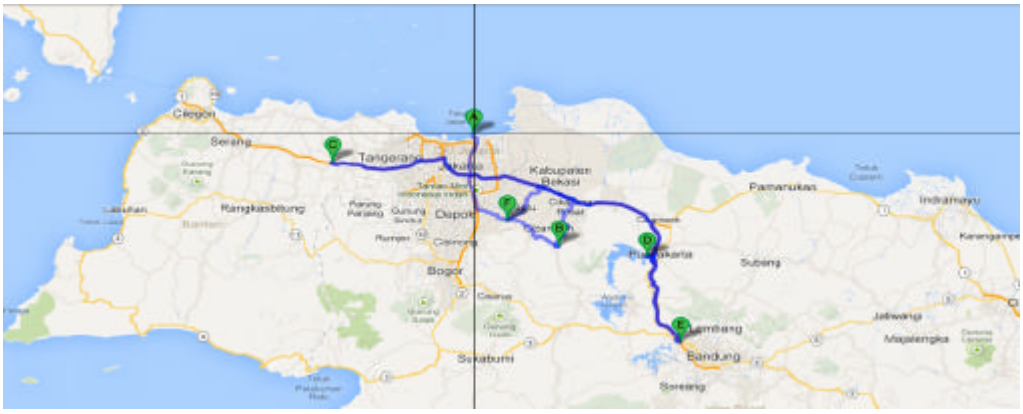

Fig. 2: Delivery map

Table 4: Coordinate point table

Company code	Company name	Coordinate point	X coordinate	Y coordinate
-	Pelabuhan Tanjung Priok	A	0.0	0.0
PD	Pindo Deli Pulp and Paper Mills, Ltd.	B	1.2	2.1
IK	Indah Kiat Pulp and Paper Mills, Ltd.	C	-2.0	0.5
IR	IndoRama Synthetics, Ltd.	D	2.5	2.0
UJ	Ultra Jaya Milk Industry, Ltd.	E	3.0	3.3
AK	Aspex Kumbong, Ltd.	F	0.5	1.5

Table 5: Retain (truck)

Company	Travel time (h)	Speed (km h^{-1})	Distance of the travel time (km)	Distance from the map (km)	Differences (km)
Pindo Deli Pulp and Paper Mills, Ltd.	3.00	40	120.00	70.20	49.80
Indah Kiat Pulp and Paper Mills, Ltd.	2.50	40	100.00	60.40	39.60
IndoRama Synthetics, Ltd.	3.13	40	125.32	109.00	16.32
Ultra Jaya Milk Industry, Ltd.	3.83	40	153.32	144.00	9.32
Aspex Kumbong, Ltd.	1.77	40	70.64	45.40	25.24
Total	-	-	-	-	140.28

The retain is 140.28/5 = 28.06 km

Table 6: The real distance matrix

Variables	X0	PD	IK	IR	UJ	AK
X0	0.00					
PD	3.21	0.00				
IK	2.25	5.76	0.00			
IR	1.50	-1.29	-2.25	0.00		
UJ	7.89	-0.36	2.84	1.19	0.00	
AK	1.75	1.06	-1.50	2.25	5.74	0

(0.0) that X0 or the Port of Tanjung Priok (Jakarta) as shown as point A (Table 4). Example of coordinate calculation:

$$\text{Coordinate}(A, B) = \sqrt{(xa - xb)^2 + (ya - yb)^2} \rightarrow \text{formula}$$

$$\text{Coordinate}(XO, PD) = \sqrt{(0-1.2)^2 + (0-2.1)^2} = 3.20$$

$$\text{Coordinate}(IR, AK) = \sqrt{(2.5-0.5)^2 + (2-1.5)^2} = 2.25$$

Steps in gaining retain are as follows:

- Getting the travel time (h)
- Calculating the distance from the company to each customers (km)
- Average truck's speed data (km/h)
- Calculating the retain

Average resistance values obtained will be added to each value of the distance matrix is obtained (Table 5). The addition is done will cause the value of the resulting distance matrix will change. Here is the matrix X0 is the distance from the port of Tanjung Priok up to AK which is Aspex Kumbong, Ltd. (Table 6 and 7).

Identification of saving matrics: Saving matrics show that will be a save when a vehicle visting several location. Simultaneously than by visiting the location one by one. The calculation determines saving matrix using the formula of:

Table 7: Distance matrix with retain

Variables	X0	PD	IK	IR	UJ	AK
X0	0.00					
PD	31.27	0.00				
IK	30.31	33.82	0.00			
IR	29.56	26.77	25.81	0.00		
UJ	35.95	28.42	30.89	29.25	0.00	
AK	29.81	29.12	26.56	30.31	33.79	0

Table 8: Saving matric

Variables	PD	IK	IR	UJ	AK
PD	0.00				
IK	27.76	0.00			
IR	34.02	34.51	0.00		
UJ	38.79	37.84	36.26	0.00	
AK	31.96	30.99	30.25	31.96	0

$$S(x,y) = \text{Dist}(DC,x) + \text{Dist}(DC,y) - \text{Dist}(x,y)$$

Saving matric and results:

- S(1.2) = 31.27+30.31-33.82 = 27.76
- S(1.3) = 31.27+29.56-26.77 = 34.02
- S(1.4) = 31.27+35.95-28.42 = 38.79
- S(1.5) = 31.27+29.81-29.12 = 31.96
- S(2.3) = 30.31+29.56-25.81 = 34.51
- S(2.4) = 30.31+35.95-28.42 = 37.84
- S(2.5) = 30.31+29.81-29.12 = 30.99
- S(3.4) = 29.56+35.95-29.25 = 36.26
- S(3.5) = 29.56+29.81-29.12 = 30.25
- S(4.5) = 35.95+29.81-33.79 = 31.96

From the earlier calculations contained in the known amount of savings obtained. So, they make a saving metrics (Table 8).

Allocate consumers to the route: At this stage, the service user company is divided into the travel route by considering the number of requests from the company with the truck capacity used. Allocation is to sort the values of matric saving which has the highest value to the lowest, so that all the companies included in the route (Table 9).

Table 9: Ordering value of saving matric

Set of companies of service user	Saving matric values
PD-UJ	38.79
IK-UJ	37.84
IR-UJ	36.26
IK-IR	34.51
PD-IR	34.02
PD-AK	31.96
UJ-AK	31.96
IK-AK	30.99
IR-AK	30.25
PD-IK	27.76

Table 10: Distance using the Farthest Insert Method (first step)

Routes	Distance (km)
X0-PD-X0	62.46
X0-IK-X0	60.62
X0-IR-X0	59.12
X0-UJ-X0	71.89
X0-AK-X0	59.62

The longest distance is 71.892 km of route to UJ (Ultra Jaya Milk Industry Ltd.)

Table 11: Distance using Farthest Insert Method (second step)

Routes	Distance (km)
X0-IR-UJ-X0	101.76
X0-PD-UJ-X0	105.97
X0-IK-UJ-X0	104.09
X0-AK-UJ-X0	97.71

Sort the service user companies in the travel route using the Farthest Insert Method: In this stage, the company determined the route where service users will be taken in advance, so as to minimize the operating cost in this case is a fuel truck. The method used is the Farthest Insert Method to obtain the sequence of the route to be taken with the lowest distance.

Ordering route that will be taken using the Insert Method Farthest, first sort the distance from the port to the location of the company and the service user back to port again (go home). The steps are as (Table 10).

After that the next step is to enter the enterprise service users one by one in order to get the furthest distance but that included only one company alone as implemented (Table 11).

Obtained from the earlier route is the farthest distance the consumer inserts UJ (Ultra Jaya Milk Industry Tbk. Ltd.) into the company to PD (Pindo Deli Pulp and Paper Mills, Ltd.) with a distance of 105.97 km. Then, the next step is the insertion of the consumer is left to the route that has been obtained in the previous step and of every one of consumers will look for the closest distance of the route (Table 12).

The next stage is the insertion of the consumer is left to the route that has been previously obtained in the third step and of each insertion one consumers conducted will look for the route that can produce the closest distance (Table 13). The final step is to enter the final consumer is left to the new route (Table 14).

Table 12: Distance using Farthest Insert Method (third step)

Routes	Distance (km)
X0-IR-UJ-PD-X0	135.84*
X0-UJ-IR-PD-X0	137.45
X0-UJ-PD-IR-X0	138.32
X0-IK-UJ-PD-X0	138.17
X0-UJ-IK-PD-X0	132.77*
X0-UJ-PD-IK-X0	132.81
X0-AK-UJ-PD-X0	131.83
X0-UJ-AK-PD-X0	131.09*
X0-UJ-PD-AK-X0	136.51

From the smallest route obtained from each insertion is done per-consumer (smallest route marked with*) is obtained which produces the greatest distance the IR (Indorama Synthetics, Ltd.) route X0-IR-UJ-PD-X0 with distance of 135.84 km

Table 13: Distance using Farthest Insert Method (fourth step)

Routes	Distance (km)
X0-IK-UJ-IR-PD-X0	169.64
X0-UJ-IK-IR-PD-X0	173.53
X0-UJ-IR-IK-PD-X0	165.69
X0-UJ-IR-PD-IK-X0	164.28*
X0-AK-UJ-IR-PD-X0	163.26*
X0-UJ-AK-IR-PD-X0	163.39
X0-UJ-IR-AK-PD-X0	165.63
X0-UJ-IR-PD-AK-X0	167.98

From the smallest route in each insertion can be made per-consumer (smallest route marked with*), obtained by the route that produces the greatest distance that IK (Indah Kiat Pulp and Paper Mills, Ltd.) with the route X0-UJ-IR-PD-IK-X0 with a distance of 164.28 km

Table 14: Distance using Farthest Insert Method (fifth step)

Routes	Distance (km)
X0-AK-IK-UJ-PD-IR-X0	201.01
X0-IK-AK-UJ-PD-IR-X0	195.63
X0-IK-UJ-AK-PD-IR-X0	195.63
X0-IK-UJ-PD-AK-IR-X0	198.69
X0-IK-UJ-PD-IR-AK-X0	170.76

This last step, obtained last consumer is AK (Aspex Kumbong, Ltd.) routenya ie X0-IK-UJ-PD-IR-AK-X0 that distance = 170.76 km

Table 15: Visit order Farthest Insert Method

Trucks	Routes	Distance (km)
B 9167 ZO	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9172 ZO	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9293 UEK	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9294 UEK	X0-IK-UJ-PD-IR-AK-X0	170.76
A 9299 UA	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9300 UEI	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9054 SU	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9204 UEJ	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9213 UEJ	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9214 UEJ	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9215 UEJ	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9627 UEL	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9864 UU	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9554 GJ	X0-IK-UJ-PD-IR-AK-X0	170.76
B 9703 JN	X0-IK-UJ-PD-IR-AK-X0	170.76

The order of visits: Ordering a visit to the Farthest Insert Method (Table 15). Route used only one because all the companies have been by passed by the service users truck, so the route is used that route.

Table 16: Cost comparison

Truck			Cost (IDR)							
			Variables						Totals	
Police number	Merek and type	Years	Fuel	Depreciation	Labor	Truck tax	Maintenance	Container payment	After application	Before implementation
B 9167 ZO	HINO/SG260J	2008	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9172 ZO	HINO/SG260J	2008	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9293 UEK	HINO/SG260J	2012	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9294 UEK	HINO/SG260J	2012	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
A 9299 UA	HINO/SG260J	2007	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9300 UEI	HINO/SG260J	2011	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9054 SU	SCANIA/P92MA	1995	862,260	283,000	172,000	15,000	160,000	1,000,000	2,492,260	2,099,590
B 9204 UEJ	Nissan MITS.6D16	2007	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9213 UEJ	Nissan MITS.6D16	2007	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9214 UEJ	Nissan MITS.6D16	2007	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9215 UEJ	Nissan MITS.6D16	2007	862,260	380.000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9627 UEL	HINO/J08E	2013	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9864 UU	HINO/J08E	2010	862,260	380,000	172,000	20,000	160,000	1,000,000	2,594,260	2,201,590
B 9554 GJ	MAN/WMAF 550	1997	862,260	283,000	172,000	15,000	160,000	1,000,000	2,492,260	2,099,590
B 9703 JN	MAN/WMAF 550	1994	862,260	283,000	172,000	15,000	160,000	1,000,000	2,492,260	2,099,590
Total									38,607,900	32,717,850

Cost comparison: Table 16 shows the company when applying Farthest Insert Method will get a saving of approximately of IDR. 5,890,050 (38,607, 900-32, 717,850) compared to before applying the method.

CONCLUSION

From the research that has been done could be concluded that the method of determining the route delivery procedures with menggukan 15 truck container of 40 feet of core Mandiri Persada Ltd. is engaged in the transportation freight import ekport the route from the Port of Tanjung Priok (Jakarta) to 5 location of the service user, Padalarang (Bandung West), Jatilahur (Purwakarta), Cileungsi (Bogor), Kerawang and Serang (Banten) Farthest using the Insert method can generate an optimal route than the route previously used by the company which can save operating expenses amounted IDR. 5,890,050.

LIMITATIONS

There are three main limitations in this study. First, the phenomenon of the ability to deliver products to customers in a timely manner in the right amount and in good condition will determine whether the product will eventually be competitive in the market but the reality on the ground a lot of unofficial levies imposed on trucks transporting goods performed by persons who are not responsible, so the total cost will increase whereas in this study, as it is a matter not included. Secondly because of the difficulty of collecting data on the external objective advantage, market share and other factors, research is conducted using only the key approach in the survey respondents, the information regarding the company's data only to chairman of the company, considering the best position to answer questions and obtain information about kedaan, truck number, customer number, mileage, determine delivery routes or pathways, thus the results of which can be likely to be biased considering only be obtained from a single informant. Third, data collected in this study, among other common data company that includes system sales, ordering and distribution of raw materials are running, each period sales data, customer data and data vehicle (truck) transport of goods. The data actually represent research studies leading to the shortest route but the data were taken only cross-sectional data (study period) only, so that the phenomena that appear only in the study period while the other periods phenomena can not be captured.

RECOMMENDATIONS

This study leads to operational management and future research should not only use the information top manager or production manager (operation level managers/middle managers) but other middle managers such as the marketing manager or sales manager as an informant, the results of which will help clarify whether the reported results are sensitive to the methodology of the research is done now. In other words, it is possible to have different types of respondents answering different sections viewed from various angles (e.g., marketing managers examine the various complaints of customers for products, services and time/delivery schedule). Although, the results of this study do not indicate a serious problem, however, future research should collect objective data from all external and internal sources as appropriate.

Finally, the study was conducted only in Persada Inti Mandiri Ltd. only. Future studies should involve similar industries in many areas of delivery with a view to improve the model generalization.

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