Use Of The Saving Matrix Method As An Alternative For Distribution Cost Efficiency: An Empirical Study On Log Timber Companies In Central Java

Suparjo

Abstract: The purpose of this study is to obtain the most appropriate and optimal product delivery route that can minimize distribution costs, and to determine the magnitude of distribution cost savings. The population in this study is data log companies in Central Java, and the sample of this study is data from 10 log transport companies in 10 major cities in Central Java. Analysis of determining the distribution route using the Saving Matrix method Forecasting results of the smallest MAPE, MAD, and MSE values of 0.317, 0.125, and 0.028. The results of analysis using the Saving Matrix method show the number of distribution routes can be reduced by 50%, from 20 routes to 10 routes. The original distance of 3890 kilometers can be reduced to 2238 kilometers, which means that the distance can be shortened / saved by 42.47% or around 1652 kilometers. A decrease in route resulted in lower product distribution costs and a distribution channel cost savings of 44.07%.

Index Terms: Saving Matrix Methods, Efficiency, Distribution Costs

1 Introduction

IN an effort to minimize the transportation costs of product distribution, the company must pay attention to the existing transportation network system. The transportation network system can be seen in terms of effectiveness, in the sense of being safe, high accessibility, integrated, sufficient capacity, regular, smooth, fast, easy to reach, timely, comfortable, affordable, orderly, safe and low pollution rates and in terms of efficiency in means having high utility in a single network transportation system. To anticipate this problem, we need a method that can provide minimal product distribution costs. Savings Matrix method is a method used to determine the product distribution route to the marketing area by determining the distribution route that must be passed and the number of vehicles based on vehicle capacity in order to obtain the shortest route and minimal transportation costs. Savings Matrix method is also one of the techniques used to schedule a limited number of vehicles from facilities that have maximum capacity (Erlina, 2009). By using the Savings Matrix Method, it is expected to help overcome the problems above, so that the company is able to plan well on each product that will be sent, both regarding the number of products and their purpose. In this study, it took the object of research in log wood transportation service companies in the city of Semarang.

2 Literature Review

2.1 Distribution Management

Distribution covers all aspects of product delivery to consumers. Turner & Heizer (2000) states that the distribution channel is a path through which the flow of goods from the producer to the intermediary and finally reaches the user. In addition, distribution can also be interpreted as channeling institutions that have activities to distribute goods or services from producers to consumers. Manufacturers must consider various kinds of factors that are very influential in the selection of distribution channels. The selection of an effective distribution channel will be able to encourage the expected increase in sales, so that the company's survival can be guaranteed (Lubis, 2004). Distribution channels are one of the marketing mix tools that can determine the success or failure of marketing carried out by a company. Therefore, an effective distribution channel, must be able to further support the effective implementation of marketing (Kotler, 2006). Transportation is a factor that must be considered, because transportation activities include the process of transporting and moving goods or products to a destination that requires no small cost. Transportation is defined as a business and activities transporting or carrying goods and or passengers from one place to another. In addition, the transportation or transfer of passengers or goods by transportation is to reach the destination and increase the utility or usefulness of the goods being transported. There are two types of utilities that can be created by transportation, namely Place Utility and Time Utility. Each form of transportation has four main elements of transportation, namely roads, vehicles and transportation equipment, driving forces, and terminals (Kadir, 2006). In modern transportation systems, transportation is an integral part of community functions and activities. There is a very close relationship with lifestyle, reach, location of production activities, fulfillment of goods, and services available for consumption. The growing development of human civilization today, is able to make transportation a single chain of life that is very influential in the development of society. In a network of facilities, transportation is a chain of connecting eyes. In recent years, transportation management has received a lot of attention from various companies. Almost every company of various sizes is certain to have a manager who is fully responsible for managing its transportation program. In general, a company has three alternatives to determine its transportation capabilities. The first alternative is the fleet of equipment that can be purchased or rented. Second, a special contract can be arranged with a

- *Suparjo, Faculty of Economics and Business Universitas 17 Agustus 1945 Semarang*

transportation specialist to get a contract for transportation services. Third, a company can obtain services from a legally authorized transportation company that offers transportation from one place to another at a certain cost. These three forms of transportation are known as private, contract, and public transportation. When viewed from a logistical perspective, there are three factors that play a major role in determining the ability of transportation services, namely cost, speed, and consistency (Bowersox, 1995).

2.2 Method of Saving Matrices

Saving Matrix is a method used to determine the distance, route, time or cost in carrying out the delivery of goods from the company to the consumer. This method aims to make the delivery of goods according to consumer orders can be done in an effective and efficient way, so that the company can save costs, energy and delivery time (Istantiningrum, 2010). The saving matrix method consists of several steps. According to Istantiningrum (2010) the steps in the saving matrix method are as follows: In determining this distance matrix, the distance data between the company and the location and location to other locations is very necessary. After knowing the coordinates of each location, the distance between the two locations can be calculated using the following formula:

$$j(1,2) = \sqrt{(x_1 - x_2) + (y_1 - y_2)}^2$$

However, if the distance between the two coordinates is known, the calculation using the formula is not used and uses the existing distance. After knowing the overall distance, namely the distance between the plant and the location and location with the other locations, then in this step it is assumed that each location will be passed by one truck exclusively. This means that there will be several different routes that will be skipped for each purpose. Thus there will be savings if there is a merger of routes that are considered one-way with the other routes. To find the saving matrix you can use the following formula:

$$S(x,y) = J(x,y) + J(x,y) - J(x,y)$$

S (x, y) is a distance saving that is from the merging of route x with route y.

After the savings matrix is known, the next step is to allocate the location to the route or vehicle. This means that in this step a new shipping route will be determined based on the merging of routes in the second step above. The result is that location 1 and location 2 will be sent using 1 route. The next step is ordering the destination location in a route. This step determines the order of visits. There are several methods for determining the order of visits, namely (a) nearest Insert Method, and (b) Nearest Neighbor Method. The Nearest Insert Method determines the order of visits by prioritizing locations that, if included in an existing route, produce the minimum distance, while the Nearest Neighbor Method determines the visit by prioritizing the location closest to the last visited location. Last step is Production Scheduling. One of the benefits of scheduling is so that the delivery of goods can be in accordance with the time and portion that has been determined. Scheduling also has a purpose. The purpose of scheduling is that the delivery of goods is carried out sequentially in accordance with the schedule made. The schedule is in the form of a record of time which is poured into one calendar that is needed by the implementers. Some of the results of scheduling one of them is shipping according to the available route in the grouping result table so that the delivery does not exceed the capacity in sending (Istantiningrum, 2010).

3 Research Method

This research was conducted on log wood transportation service companies in Central Java by taking a sample of 10 (ten) in 10 major cities in Central Java, namely: PT. Bunga Bangsa Semarang, PT. Bunga Bangsa Serakarta, PT. Bunga Bangsa Cilacap, PT. Bunga Bangsa Purwokerto, PT. Bunga Bangsa Tegal, PT. Bunga Bangsa Pekalongan, PT. Bunga Bangsa Pati, PT. Bunga Bangsa Kudus, PT. Bunga Bangsa Blora, PT. Bunga Bangsa Purworejo The study was conducted for 5 months and was conducted in February 2016 - June 2016. The observation was performed at companies under Bunga Bangsa Group Co. Semarang by making direct observations in the field and recording the required data. The interview was conducted by holding question and answer directly to company officers to obtain more accurate data. Savings Matrix method is a method used to determine the product distribution route to the marketing area by determining the distribution route that must be passed and the number of vehicles based on vehicle capacity in order to obtain the shortest route and minimal transportation costs. Savings Matrix method is also one of the techniques used to schedule a limited number of vehicles from facilities that have maximum capacity (Erlina, 2009). By using the Savings Matrix Method, it is expected to be able to answer the research problems, and the company is able to make plans for each product to be sent, both regarding the number of products and their objectives. The software used for Minitab 16 forecasting can be useful for data entry, charting, statistical analysis, and forecasting processes.

4 Results

4.1 Consumer Demand Data

The following are data on average consumer demand from 10 logging transport companies from May 2015 to April 2016.

TABLE 1

Average Consumer Demand Data of Bunga Bangsa Group.Co

No.	Consumer Code	Average demand	No.	Consumer Code	Average demand
1.	A	614	11.	A	585
2.	B	643	12.	B	522
3.	C	550	13.	C	614
4.	D	734	14.	D	462
5.	E	736	15.	E	751
6.	F	601	16.	F	838
7.	G	654	17.	G	512
8.	H	488	18.	H	815
9.	I	631	19.	I	682
10.	J	691	20.	J	621

4.2 Early Route

Of the 10 companies, there are transportation equipment in the form of 96 trucks. Each conveyance has a maximum capacity of 15000 Kg. The company's initial route is 20 routes. The company's initial route is warehouse-consumer-

warehouse. The following are data on the average route of product delivery along with distance data on each route:

TABLE 2

INITIAL AND DISTANCE ROUTES OF BUNGA BANGSA GROUP.CO

No.	Consumer	Distance (Km)	No.	Consumer	Distance (Km)
1.	G-A-G	56	11.	G-K-G	300
2.	G-B-G	94	12.	G-L-G	202
3.	G-C-G	190	13.	G-M-G	456
4.	G-D-G	216	14.	G-N-G	154
5.	G-E-G	460	15.	G-O-G	226
6.	G-F-G	160	16.	G-P-G	92
7.	G-G-G	64	17.	G-Q-G	128
8.	G-H-G	106	18.	G-R-G	240
9.	G-I-G	54	19.	G-S-G	282
10.	G-J-G	108	20.	G-T-G	302

The total distance produced on this initial route is 3890 kilometers. The distance on the initial route is considered too long and must be trimmed so as not to cause long delivery times and high transportation costs.

4.3 Consumer Distance Data

Data on the distance between warehouse and consumer and the distance between consumers are shown in the table below:

TABLE 3

CONSUMER DISTANCE (KM) OF BUNGA BANGSA GROUP.CO

	GDG	A	B	C	D	E	F	G
GDG	0	28	47	95	108	230	80	32
A	28	0	18	48	79	203	44	58
B	47	18	0	40	82	205	40	24
C	95	48	40	0	35	233	79	109
D	108	79	82	35	0	261	108	113
E	230	203	205	233	261	0	177	222
F	80	44	40	79	108	177	0	78
G	32	58	24	109	113	222	78	0
H	53	79	82	123	155	175	44	39
I	27	53	73	103	92	257	89	33
J	54	65	86	117	86	272	117	66
K	150	129	124	165	209	82	87	144
L	101	90	85	125	154	130	47	106
M	228	186	175	202	266	40	159	213
N	77	47	37	78	105	158	22	100
O	113	104	124	155	152	273	140	55
P	46	73	92	100	108	263	109	52
Q	64	69	97	61	34	270	111	95
R	120	94	75	102	144	122	50	130
S	141	112	103	76	44	308	141	137
T	151	114	119	92	70	324	167	143

4.4 Identification of Saving Matrix

The savings matrix is obtained by combining two or more consumer routes simultaneously. The merger is adjusted to the number of consumer requests. The amount of incorporation of consumer demand is not allowed to exceed the capacity of the conveyance.

TABLE 4

MATRIX FOR SAVINGS

	A	B	C	D	E	F	G	H
A	0							
B	57	0						
C	75	102	0					
D	57	73	168	0				
E	55	72	92	77	0			
F	64	87	96	80	133	0		
G	2	55	18	27	40	34	0	
H	2	18	25	6	108	89	46	0
I	2	1	19	43	0	18	26	66
J	17	15	32	76	12	17	20	15
K	49	73	80	49	298	143	38	103
L	39	63	71	55	201	134	27	92
M	70	100	121	70	418	149	47	111
N	58	87	94	80	149	135	9	65
O	37	36	53	69	70	53	90	72
P	1	1	41	46	13	17	26	14
Q	23	14	98	138	24	33	1	-5
R	54	92	113	84	228	150	22	55
S	57	85	160	205	63	80	36	10
T	65	79	154	189	57	64	40	5

4.5 Identification of Savings Matrix

The savings matrix is obtained by combining two or more consumer routes simultaneously. The merger is adjusted to the number of consumer requests. The amount of incorporation of consumer demand is not allowed to exceed the capacity of the conveyance. Following is the savings matrix table:

TABLE 5
MATRIX FOR SAVINGS

Rating	Value	Rating	Value	Rating	Value	Rating	Value
1	418	11	201	21	149	31	111
2	305	12	189	22	143	32	111
3	298	13	168	23	138	33	110
4	264	14	165	24	135	34	110
5	245	15	164	25	134	35	109
6	228	16	160	26	133	36	108
7	208	17	157	27	132	37	104
8	205	18	154	28	122	38	103
9	202	19	150	29	121	39	102
10	202	20	149	30	113	40	100

4.6 Verification Test with MRC (Moving Range Chart)

Verification test for forecasting results is needed to find out whether the forecasting method used is representative of the data or not. In addition, the Moving Range Chart is used to compare the value of the actual observation with the forecast value of a request (Fauzan & Rahmayanti, 2013). The following is the graph:

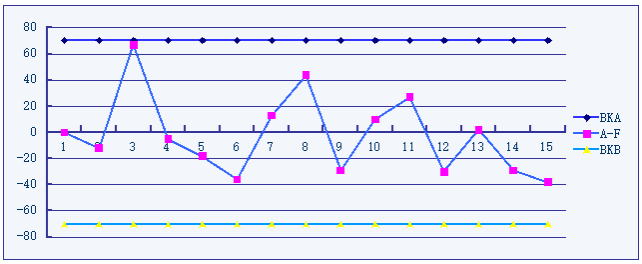

Figure 2 *Moving Range Time Series Regression Chart*

Based on the graph above, it can be seen that there is no data that is outside the upper control limit or the lower control limit. Thus, the Linear Regression method can be said to be appropriate or representative of this research.

4.7 Analysis of forecasting methods

Based on the type and pattern of the data obtained is the trend pattern, the forecasting technique chosen and will be compared is the Simple Linear Regression method and the Hot's Linear Exponential Smoothing (Winter) method, and the best forecasting technique is based on the smallest MSE (Mean Square Error) value. Forecasting results based on the two methods used show that forecasting with the Linear Regression method has the smallest MAPE, MAD, and MSE values of 0.317, 0.125, and 0.028. Comparison of forecasting which has the smallest forecasting error will be used as information for predicting consumer demand for the next period (Tanuwijaya, 2010). The verification process is needed if a prediction method is used. Verification of forecasting results is needed to see whether the forecasting method obtained is representative of the data or not. The verification process is done using the Moving Range Chart (MRC). Moving range maps are used to compare the actual observation value with the forecast value of a request. In this study, based on graph 4.2, it appears that there is no data that is outside the upper or lower control limits. Thus, the Linear Regression method can be said to be appropriate or representative of this research and can be used to predict consumer demand in the next year. By referring to the savings matrix table, customer allocation processes can be carried out.

The allocation of each consumer into one route can be combined up to the limit of the transportation capacity of the company. The merger starts from the biggest savings value. Starting from the savings value of 418 which is a savings from the merger between consumer E and consumer M. The amount of each consumer's burden is 7360 Kg and 6140 Kg, while the total load is 13500 Kg. The total is still below the maximum limit of transport capacity, which is 15000 Kg. Thus the merger is feasible, consumer E and consumer M join in route 1, and so on. Next is to sort consumers in a defined route. In principle, the purpose of this sorting is to minimize the travel distance of the conveyance. Route determination is done by the Nearest Insert method. The Nearest Insert method is done by selecting consumers who, if inserted into an existing route, produce additional minimum distances. At first it only had a trip from the warehouse to the warehouse with a zero distance, then it was seen how much distance occurred by adding each consumer to the existing route. The results are as follows:

$$G - E - G = 460\ Km$$

$$G - M - G = 456\ Km$$

Since the minimum distance produced from both is 456 kilometers, the consumers visited are consumers M. The route formed is G-M-E-G, and so on.

4.8 Proposed Product Distribution Routes

From the results of processing and analyzing the data above, the number of routes to be taken by Bunga Bangsa Co. to distribute its products over the next year, there are 10 routes. The route is grouped according to the results of data processing using the Saving Matrix method. In addition, the shorter the total distance traveled, the smaller the time taken (Ramadanti, et al., 2013). The proposed determination of the product distribution route at Bunga Bangsa Co is as follows:

TABLE 6
PROPOSED DISTRIBUTION ROUTES

No.	Route	Delivery Schedule	Total Distance (KM)	Total Order Load (KG)	Conveyance
1.	ROUTE 1	G-M-E-G	498	13720	TRUCK A
2.	ROUTE 2	G-O-T-G	426	10540	TRUCK C
3.	ROUTE 3	G-D-S-G	94	13070	TRUCK C
4.	ROUTE 4	G-L-K-G	190	12760	TRUCK A
5.	ROUTE 5	G-N-R-G	237	10960	TRUCK A
6.	ROUTE 6	G-B-C-G	182	11010	TRUCK B
7.	ROUTE 7	G-H-F-G	117	10180	TRUCK B
8.	ROUTE 8	G-P-J-G	241	14240	TRUCK C
9.	ROUTE 9	G-I-G-G	92	10590	TRUCK B
10.	ROUTE 10	G-A-Q-G	161	14120	TRUCK B

5 CONCLUSION

Along with the development of technology at this time has encouraged many companies to produce products that are creative, innovative, and strive to produce higher competitive value for the company. Distribution is a product distribution strategy that is used by producers to distribute their products to consumers so that they can be accepted quickly, precisely, and in good condition. Allocation of products and determination of route of delivery of goods with which is important in an industry, both small scale and large scale industries. Errors in determining the distribution channel and delays in product delivery can hinder the distribution of products from producers to consumers, which can result in reducing company profits and can also have the potential for losses to the company. The results show that the proposal for the product distribution route at Bunga Bangsa Co. Group has been formed. The total route that must be taken for product delivery is as many as 10 routes with a load capacity of around 15000 Kg. Each route has different consumer goals. The grouping of consumers is based on the allocation of the highest savings matrix with the Saving Matrix method. Value of savings has an effect on saving total distance. The greater the value of savings obtained, the more savings in total distance obtained.

REFERENCES

[1] Bowersox, D. J., Calantone, R. J., Clinton, S. R., Closs, D. J., Cooper, M. B., Droge, C. L., ... & Rinehart, L. M. (1995). World Class Logistics: the challenge of managing continuous change. Council of Logistics Management, Oak Brook, IL.

[2] Erlina, P. (2009). Mengoptimalkan Biaya Transportasi Untuk Penentuan Jalur Distribusi. Jurnal Penelitian Ilmu Teknik, 9(2), 143-150.

[3] Istantiningrum, M. (2010). Penentuan Rute Pengiriman Dan Penjadwalan Dengan Menggunakan Metode Saving Matrix Study Kasus Pada PT. Sukanda Djaya Yogyakarta. Yogyakarta: Program Studi Teknik Industri UIN Sunan Kalijaga.

[4] Kadir, A., 2006. Transportasi: Peran dan Dampaknya Dalam Pertumbuhan Ekonomi Nasional. Jurnal Perencanaan & Pengembangan Wilayah WAHANA HIJAU Vol.1 No. 3, pp. 121-131.

[5] Kotler, P., Wong, V., Saunders, J. A., & Armstrong, D. G. M. (2006). Osnove marketing. Mate.

[6] Lubis, A. N., 2004. Peranan Saluran Distribusi Dalam Pemasaran Produk Dan Jasa. e-USU Repository, pp. 1-14.

[7] Tanuwijaya, H., 2010. Penerapan Metode Axponential Smoothing Winter Dalam Sistem Informasi Pengendalian Persediaan Produk dan Bahan Baku Sebuah Cafe. SemnasIF ISSN 1979-2328, pp. 219-225.

[8] Raharja, A., Angraeni, W. & Vinarto, A. R., 2013. Penerapan Metode Exponential Smoothing Untuk Peramalan Penggunaan Waktu Telepon di PT. Telkomsel Surabaya. SISFO-Jurnal Sistem Informasi, pp. 1-9.

[9] Fauzan, A. & Rahmayanti, D., 2013. Optimalisasi Sistem Persediaan bahan Baku Karet Mentah (Lateks) Dengan Metode Lot Sizing. Jurnal SOptimasi Sistem Industri ISSN 2088-4842, pp. 317-325.

[10] Turner, W. C. & Heizer, J., 2000. Pengantar Teknik & Sistem Industri Edisi Ketiga Jilid 1. Surabaya: Guna Widya.