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Analysis of Bulk Cement Distribution Network Considering Market Share and Operating Income after Acquiring the Competitor

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***Abstract*—The distribution network is the most important strategic decision issues that need to be optimized for the efficient operation of whole supply chain. When a company make a business acquisition that brings more distribution facilities, the location allocation planning of the distribution network needs to be reconsidered. The distribution network includes the link from factories to packing plants and from factories or packing plants to demand points. The linear programming model was developed as a solution to solve optimization problem which involves multisource, multiproduct, and multipored in multi-echelon distribution network. We build numerical experiments from two scenarios to show the behaviour of this model. This model will determine the decision of distribution facilities location should be used and quantities should be allocated to achieve the optimal operating income considering the market share policy to satisfy the customer demands.**

***Keywords*—Distribution Network, Linear Programming, Location Allocation, Market Share, Operating Income.**

I. INTRODUCTION

THE network design is a fundamental thing done in supply chain management, where it will affect all other decisions that exist in a supply chain and has a great influence on investment returns and overall supply chain performance, it was further conveyed that mergers and acquisitions can make the company integrates different logistics networks [1]. The design of the supply chain network involves strategic decisions including determining the number, location and capacity of distribution facilities to meet consumer demand effectively and efficiently [2]. Decisions in supply chain design can result in a supply chain configuration that has a significant impact on logistics and responsive costs [3]. The supply chain network can be used to achieve the company's supply chain objectives, namely low supply chain operating costs to a high level of responsiveness to customer demand. So if an organization / company wants to increase its productivity and profitability, an effective and efficient supply chain network design is absolutely necessary. The benefits of managing supply chain networks by integrating operational, design and financial decisions that have an objective to determine the optimal configuration of production and distribution networks with operational constraints, including quality, production (ie supply restrictions related to production allocation and capacity balance) and finance (i.e. production costs, transportation costs, and other costs incurred along the network through which materials and products flow) [4].

The design of the distribution network consists of three parts including location-allocation, vehicle routing problems, and inventory control [5]. Location-allocation is defined as the unity of the location of the customer whose request is known and the unity of the location of available facilities. When the facilities have been determined there will be a fixed fee, there will also be a delivery fee between the candidate location that will be used and the location of the customer. So the facility location and delivery pattern between the facility and its customers will be sought to achieve the desired objectives [6][7]. These objectives are classified into four categories namely minimizing costs, demand orientation, profit maximization, and environmental problems [8].

In this paper, we developed linear programming model to solve the location allocation model of the distribution network after the bussiness acquisition policy done by cement company in Indonesia by considering the market share. Therefore, this study aims to develop a location allocation model of the distribution network to optimizing the operating income by considering the market share of the cement company which recently make a bussiness acquisition policy of a similliar company. This paper devided into 5 section. Section 1 describe the research background. Section 2 provides literature review especially for proposed model. Section 3 present the proposed model. Section 4 provides the case of the location allocation of the distribution network of an Indonesian cement company. And the last section will be discusses about conclusion and future research.

II. LITERATURE REVIEW

Pujawan describe the location of allocations in the supply chain network [2]. Decisions on the establishment or use of a production facility or place of storage are often made simultaneously with other decisions such as the allocation of production and delivery. And it becomes more complex when the capacity constraints of production and storage are included in the decision. Where if there are a number of distribution facilities (both factory and storage) that are in several different places with a limited capacity to serve the entire marketing area of the company that has a different level of demand from one another. Therefore a linear programming is needed to determine simultaneously which production facilities will serve the marketing area and which factories will supply the inventory in the storage area.

The discussed of the planning of capacity location allocation from distribution centers for distribution network

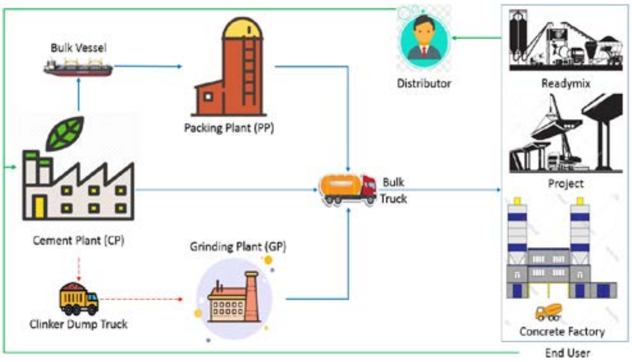

Figure 1. Illustration of Supply Chain Distribution Network for Bulk Cement.

design by considering between factories to distribution centers and distribution centers to the point of demand by exploring the optimal number and locations of distribution centers in the X cement industry in Myanmar [9]. Solving problems using mixed integer linear programming (MILP) consisting of three factories, six distribution centers, and six market areas. The MILP model provides useful information for the Company about which distribution centers are opened and the best distribution networks to maximize profits while still meeting customer demands. There are three scenarios which in all scenarios, the solution is to have only two distribution centers from the Mandalay and Meikhtila markets that are recommended to be opened in the distribution network.

The examined the supply chain distribution network that focused on maximizing the profitability of location - inventory in multiculturality that is sensitive to price demand [10]. Determination of location, allocation, price, with a large size of the volume of orders from customers intended to maximize the total profit that can be achieved. Using a mixed integer non linear programming model that is solved by the lagrangian relaxation algorithm in the case of a capacity distribution center and not capacity. The results obtained indicate the existence of optimal quasi tolerance that can be accepted with a small computational time can solve the problem of large cases.

The models of the allocation location of a distribution network in a company with the aim of maximizing earnings before interest, taxes, depreciation, and amortization (EBITDA) while still considering market share in accordance with company policy [11]. The model created resulted in an increase in EBITDA of 10.54% and an increase in the allocation of market share for sales areas where the Company is a market leader and market challenger and in the area of follower and nicher markets on average there was a decrease in market share allocation.

Van Dijk writes about supply chain distribution networks in multicommodity parcel companies [12]. The purpose function is to maximize profits and maintain market share. Market share itself depends on the price and time of service provided to customers. The solution approach used is to integrate processes such as determining prices, determining demand, then minimizing costs on the distribution network. Using new metaheuristic algorithm based on local branching. There are two situations for optimization, where the first optimization situation is only on price and routing by linearizing the objective function to estimate the original non-linear model so that the formulation with the heuristic method is used with MILP to find the optimal solution. The

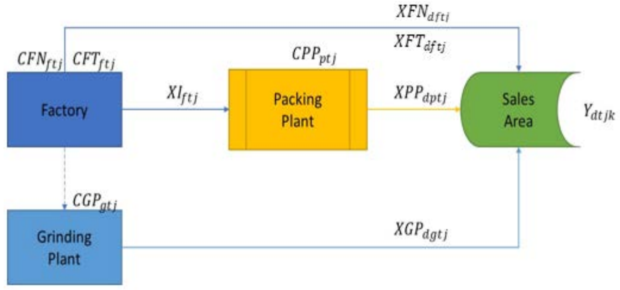

Figure 2. Conceptual Model.

second optimization situation is done in price, routing, and distribution network. The problem solving approach uses the same thing as the first situation by adding a meta heuristic algorithm based on neighborhood search and local branching variables that are run with MILP. The results given get the optimal solution where the more complex the distribution network that is built the longer the system is to do the calculations.

This study attempts to develop location allocation model of the distribution network in an Indonesian cement company who recently make a acquisition bussiness policy to optimizing the operating income by considering the market share.

III. MODEL FORMULATION

A. Problem Description

The supply chain distribution network based on product flow as depicted in Figure 1. This complex supply chain network includes multisources, multiechelon, multiproduct multiperiode with considering market share policy for optimizing operating income.

A hypothetical capacity allocation problem will be considered based on the network, where multiple products can be distributed within a time horizon of 12 months. The aim is to determine how capacities should be allocated optimally to distribute the product items in a complete supply chain, whereby the capacity constraints of supply, distribution, and market share are considered simultaneously. Here, distribution facilities capacity is defined as the available supply volume in each plant and each period, and the capacity of each plant is independent of the others; the supply capacity is the maximum amount of product that can be provided by each distribution facility in each period. In addition, some other factors, such as type of product and market share policy, are considered.

The problem for the proposed model is determining the allocation of volume of the products to be distributed to sales area from each plant (factory, packing plant, grinding plant) in order to satisfying the demand. The objective is maximizing the operating income that generated by income from the sales price minus by cost of good sold, cost of sales marketing, cost of general and administrative, and cost of last miles delivery. The model restricted by some assumptions. The volume of the demand using the forecasting demand from the company. Demand fulfillment modelled as two scenarios, delivered it in full and delivered it based on the market share policy. The both scenarios aims to get the maximum operating income. The boundary of this model is the use of distribution facilities only in Java because it can already represent the entire distribution

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Table 1.
Distribution Facilities Capacity (Tonnage)

Product	OPC							PCC						
Plant	Tuban	Rembang	Narogong	Banyuwangi	Gresik	Priok	Ciwandan	Tuban	Rembang	Narogong	Banyuwangi	Gresik	Priok	Ciwandan
Jan	465.000	155.000	77.500	N/A	62.000	77.500	77.500	310.000	310.000	N/A	77.500	15.500	N/A	77.500
Feb	420.000	140.000	70.000	N/A	56.000	70.000	70.000	280.000	280.000	N/A	70.000	14.000	N/A	70.000
Mar	465.000	155.000	77.500	N/A	62.000	77.500	77.500	310.000	310.000	N/A	77.500	15.500	N/A	77.500
Apr	450.000	150.000	75.000	N/A	60.000	75.000	75.000	300.000	300.000	N/A	75.000	15.000	N/A	75.000
Mei	465.000	155.000	77.500	N/A	62.000	77.500	77.500	310.000	310.000	N/A	77.500	15.500	N/A	77.500
Jun	450.000	150.000	75.000	N/A	60.000	75.000	75.000	300.000	300.000	N/A	75.000	15.000	N/A	75.000
Jul	465.000	155.000	77.500	N/A	62.000	77.500	77.500	310.000	310.000	N/A	77.500	15.500	N/A	77.500
Agu	465.000	155.000	77.500	N/A	62.000	77.500	77.500	310.000	310.000	N/A	77.500	15.500	N/A	77.500
Sep	450.000	150.000	75.000	N/A	60.000	75.000	75.000	300.000	300.000	N/A	75.000	15.000	N/A	75.000
Okt	465.000	155.000	77.500	N/A	62.000	77.500	77.500	310.000	310.000	N/A	77.500	15.500	N/A	77.500
Nov	450.000	150.000	75.000	N/A	60.000	75.000	75.000	300.000	300.000	N/A	75.000	15.000	N/A	75.000
Des	465.000	155.000	77.500	N/A	62.000	77.500	77.500	310.000	310.000	N/A	77.500	15.500	N/A	77.500
Total	**5.475.000**	**1.825.000**	**912.500**	N/A	**730.000**	**912.500**	**912.500**	**3.650.000**	**3.650.000**	N/A	**912.500**	**182.500**	N/A	**912.500**

*N/A = not available

Table 2.
Market Share Policy (Lower Bound and Upper Bound)

Market Competition	Market Share (M_d in %)	Boundary Formulation	
		$Kmin_{dk}$ (%)	$Kmax_{dk}$ (%)
Nicher	0 – 9,9	M_d = 0%	2%
Follower	10 – 29,9	-5%	2%
Challenger	30 – 39,9	-5%	3%
Leader 3	40 – 59,9	-3%	3%
Leader 2	60 – 89,9	-2%	3%
Leader 1	90 – 100	M_d	M_d = 100%

network. The product is in bulk and using one of the brand of the company that has the most high market share. The product, transportation, and distribution facilities is always available and unlimited. The inbound cost already captured in the cost of goods sold. The proposed conseptual model shown in Figure 2.

B. Proposed Mathematical Model

The notations that will be used to describe the problem are as follows :

1) Indices :

d, index of sales area, where *d* = 1, ..., *D*, *D* is the number of sales area

f, index of factory plant, where *f* = 1, ..., *F*, *F* is the number of the factory

p, index of packing plant, where *p* = 1, ..., *P*, *P* is the number of the packing plant

g, index of grinding plant, where *g* = 1, ..., *G*, *G* is the number of the grinding plant

t, index of time periodes, where *t* = 1, ..., *T*, *T* is the periode of month in a year

j, index of product types, where *j* = 1, ..., *J*, *J* is the type of product that distributed

k, index of the market, where *k* = 1, ..., *K*, *K* is the type of the market competition

2) Capacity parameters :

CPP_{ptj} , capacity of packing plant *p* in time period *t* with type of product *j*

CFT_{ftj} , capacity of main factory *f* in time period *t* with type of product *j*

CFN_{ftj} , capacity of factory f in time period t with type of product j

CGP_{gtj} , capacity of grinding plant g in time period t with type of product j

3) Market & demand parameters :

M_d , market share for sales area *d*

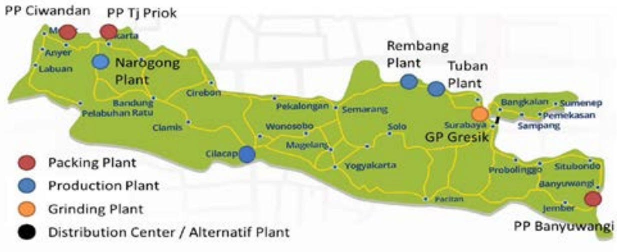

Figure 3. Distribution Facilities.

Y_{dtj} , demand volume of type product *j* for sales area *d* in time periode *t*

$KMin_{dk}$, Minimum Coefficient of market share for sales area *d* in market *k*

$KMax_{dk}$, Maximum Coefficient of market share for sales area *d* in market *k*

4) Financial parameter :

$E_{dtjf/p/g}$, operating income of product type *j* in sales area *d* with time period *t* from factory *f* / packing plant *p* / grinding plant *g*

$HT_{dtjf/p/g}$, price of of product type *j* in sales area *d* with time period *t* from factory *f* / packing plant *p* / grinding plant *g*

$BC_{dtjf/p/g}$, cost of goods sold of product type *j* in sales area *d* with time period *t* from factory *f* / packing plant *p* / grinding plant *g*

$BM_{dtjf/p/g}$, cost of sales marketing of product type *j* in sales area *d* with time period *t* from factory *f* / packing plant *p* / grinding plant *g*

$BA_{dtjf/p/g}$, cost of general administration of product type *j* in sales area *d* with time period *t* from factory *f* / packing plant *p* / grinding plant *g*

$BO_{dtjf/p/g}$, cost of last miles delivery of product type *j* in sales area *d* with time period *t* from factory *f* / packing plant *p* / grinding plant *g*

5) Decision Variabels :

XFT_{dftj} , volume of product type j in time period t from main factory f for sales area d

XFN_{dftj} , volume of product type j in time period t from factory f for sales area d

Table 3.
Cost of Good Solds, Cost of Marketing Sales, Cost of General Administrative

PLANT	COGS	GENERAL ADMIN	MARKETING SALES	SUB TOTAL COST OPC	COGS	GENERAL ADMIN	MARKETING SALES	SUB TOTAL COST OPC
Tuban Factory	440.797	12.546	10.795	464.138	341.477	12.546	10.795	364.818
Rembang Factory	512.931	12.546	10.795	536.272	512.931	12.546	10.795	536.272
Narogong Factory	602.277	12.546	10.795	625.618	N/A	N/A	N/A	N/A
Banyuwangi PP	N/A	N/A	N/A	N/A	561.137	12.546	10.795	584.478
Priok PP	712.475	12.546	10.795	735.816	N/A	N/A	N/A	N/A
Ciwandan PP	687.946	12.546	10.795	711.288	581.892	12.546	10.795	605.233
Gresik GP	630.117	12.546	10.795	653.458	N/A	N/A	N/A	N/A

*N/A = not available

Table 4.
Cost of Last Miles Delivery (example for some major cities in Java)

Last Miles Cost							
Province	East Java	East Java	Central Java	DI Yogyakarta	West Java	DKI	Banten
District	Surabaya	Banyuwangi	Semarang	Yogyakarta	Bandung	Jakarta	Tangerang
Tuban Factory	120.063	213.983	111.887	173.217	315.430	260.644	286.771
Rembang Factory	N/A	N/A	75.292	153.759	N/A	N/A	N/A
Narogong Factory	N/A	N/A	N/A	N/A	123.349	55.792	57.693
Banyuwangi PP	N/A	51.109	N/A	N/A	N/A	N/A	N/A
Priok PP	N/A	N/A	N/A	N/A	147.802	54.189	63.693
Ciwandan PP	N/A	N/A	N/A	N/A	211.814	102.438	75.412
Gresik GP	40.396	151.106	158.528	N/A	N/A	N/A	N/A

*N/A = not available

XPP_{dptj}, volume of product type j in time period t from packing plant p for sales area d

XGP_{dgtj}, volume of product type j in time period t from grinding plant g for sales area d

XI_{pftj}, volume flow to packing plant p of product type j in time period t from factory f for sales area d

Y_{dtjk}, demand volume of product type j for sales area d in market k with time period t

Respect to the problem defined above, a LP model Z is formulated with the objective function :

$$Maximize \sum_{d=1}^{D}\sum_{f=1}^{F}\sum_{t=1}^{T}\sum_{j=1}^{J} XFT_{dftj}EFT_{dftj} + \sum_{d=1}^{D}\sum_{f=1}^{F}\sum_{t=1}^{T}\sum_{j=1}^{J} XFN_{dftj}EFN_{dftj} + \quad (1)$$

$$\sum_{d=1}^{D}\sum_{p=1}^{P}\sum_{t=1}^{T}\sum_{j=1}^{J} XPP_{dptj}EPP_{dptj} + \sum_{d=1}^{D}\sum_{g=1}^{G}\sum_{t=1}^{T}\sum_{j=1}^{J} XGP_{dgtj}EGP_{dgtj}$$

The objective function maximizes the total operating income of the supply chain by maximizing the operating income from each factory, packing plant, and grinding plant generated by multiplied the total volume distributed to area sales d from factory f / packing plant p / grinding plant g for time period t and type product j with the operating income obtained from distributing to area sales d from factory f / packing plant p / grinding plant g for time period t and type product j . Where the operating income calculation for each factory f / packing plant p / grinding plant g given by :

a. Factory operating income calculation formula

$$EFN/T_{dftj} = \sum_{d=1}^{D}\sum_{f=1}^{F}\sum_{t=1}^{T}\sum_{j=1}^{J}(HT_{dftj} - BC_{dftj} - BA_{dftj} - BM_{dftj} - BO_{dftj}) \quad (2)$$

b. Packing plant operating income calculation formula

$$EPP_{dptj} = \sum_{d=1}^{D}\sum_{p=1}^{P}\sum_{t=1}^{T}\sum_{j=1}^{J}(HT_{dptj} - BC_{dptj} - BA_{dptj} - BM_{dptj} - BO_{dptj}) \quad (3)$$

c. Grinding plant operating income calculation formula

$$EPP_{dptj} = \sum_{d=1}^{D}\sum_{p=1}^{P}\sum_{t=1}^{T}\sum_{j=1}^{J}(HT_{dptj} - BC_{dptj} - BA_{dptj} - BM_{dptj} - BO_{dptj}) \quad (4)$$

Subject to :

1. Volume delivery from main factory to area sales & packing plant ≤ main factory capacity

$$\sum_{d=1}^{D}\sum_{f=1}^{F}\sum_{t=1}^{T}\sum_{j=1}^{J} XFT_{dftj} + XI_{pftj} \leq CFT_{ftj} \forall f \forall t \forall j \quad (5)$$

This constrains ensure that the capacity of the main factory enough for delivering product both to the area sales and to the packing plant.

2. Volume delivery from factory to area sales ≤ factory capacity

$$\sum_{d=1}^{D}\sum_{f=1}^{F}\sum_{t=1}^{T}\sum_{j=1}^{J} XFT_{dftj} + XI_{pftj} \leq CFT_{ftj} \forall f \forall t \forall j \quad (6)$$

This constrains ensure that the capacity of the factory enough for delivering product to the area sales.

3. Volume delivery from packing plant to area sales ≤ packing plant capacity

$$\sum_{d=1}^{D}\sum_{p=1}^{P}\sum_{t=1}^{T}\sum_{j=1}^{J} XPP_{dptj} \leq CPP_{ptj} \forall p \forall t \forall j \quad (7)$$

This constrains ensure that the capacity of the packing plant enough for delivering product to the area sales.

4. Volume delivery from grinding plant to area sales ≤ grinding plant capacity.

$$\sum_{d=1}^{D}\sum_{g=1}^{G}\sum_{t=1}^{T}\sum_{j=1}^{J} XGP_{dgtj} \leq CGP_{gtj} \forall g \forall t \forall j \quad (8)$$

This constrains ensure that the capacity of the grinding plant enough for delivering product to the area sales

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Table 5.
Demand and Operating Income Expected of Bulk Cement in Java

PROVINCE	VOLUME	OPERATING INCOME
BANTEN	509.000	(35.857.186.620)
DKI	498.000	(35.087.349.161)
WEST JAVA	1.041.000	(37.243.858.599)
CENTRAL JAVA	1.991.000	292.808.625.677
DIYOGYAKARTA	120.000	13.442.463.770
EAST JAVA	2.349.000	433.246.443.929
JAVA	**6.508.000**	**631.309.138.997**

*MS = Market Share

Table 6.
Operating Income for each Plant to Destination

		Operating Income						
Product	Province	East Java	East Java	Central Java	DI Yogyakarta	West Java	DKI	Banten
	District	Surabaya	Banyuwangi	Semarang	Yogyakarta	Bandung	Jakarta	Tangerang
OPC	Tuban Factory	227.027	124.453	197.574	117.679	(54.732)	56.258	(53.078)
	Rembang Factory	N/A	N/A	162.035	56.957	N/A	N/A	N/A
	Narogong Factory	N/A	N/A	N/A	N/A	(20.012)	26.116	21.564
	Banyuwangi PP	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Priok PP	N/A	N/A	N/A	N/A	(70.261)	(83.633)	(91.725)
	Ciwandan PP	N/A	N/A	N/A	N/A	(203.807)	(107.803)	(74.097)
	Gresik GP	104.378	(6.854)	(34.327)	(54.650)	N/A	N/A	N/A
PCC	Tuban Factory	181.153	128.248	185.027	N/A	N/A	56.258	N/A
	Rembang Factory	N/A	N/A	149.488	N/A	N/A	N/A	N/A
	Narogong Factory	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Banyuwangi PP	N/A	161.871	N/A	N/A	N/A	N/A	N/A
	Priok PP	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Ciwandan PP	N/A	N/A	N/A	N/A	N/A	(107.803)	N/A
	Gresik GP	58.504	N/A	N/A	N/A	N/A	N/A	N/A

*N/A = not available

Table 7.
Setup Lower Bound and Upper Bound of Market Share Policy

PROVINCE	Market Share	Market Position	Min MS	Max MS
BANTEN	27,46%	Follower	22,46%	29,46%
DKI JAKARTA	11,17%	Follower	6,17%	13,17%
WEST JAVA	27,11%	Follower	22,11%	29,11%
CENTRAL JAVA	61,25%	Leader 2	59,25%	64,25%
DI YOGYAKARTA	80,63%	Leader 2	78,63%	83,63%
EAST JAVA	66,23%	Leader 2	64,23%	69,23%
JAVA	**39,97%**	**Challenger**	**34,97%**	**42,97%**

Table 8.
Objective Function Result

RESULT	EXPECTED			SCENARIO FULL DEMAND			SCENARIO MARKET SHARE POLICY		
PROVINCE	VOLUME	OPERATING INCOME	MS	VOLUME	OPERATING INCOME	MS	VOLUME	OPERATING INCOME	MS
BANTEN	509.000	(35.857.186.620)	27,46%	509.000	14.716.646.534	27,46%	431.247	13.400.266.379	23,26%
DKI	498.000	(35.087.349.161)	11,17%	498.000	26.749.186.047	11,17%	324.326	18.246.078.643	7,27%
WEST JAVA	1.041.000	(37.243.858.599)	27,11%	1.041.000	(1.444.197.212)	27,11%	899.389	4.579.251.367	23,42%
CENTRAL JAVA	1.991.000	292.808.625.677	61,25%	1.991.000	305.787.447.347	61,25%	2.020.321	312.244.848.395	62,15%
DIYOGYAKARTA	120.000	13.442.463.770	80,63%	120.000	13.335.792.432	80,63%	121.378	13.540.419.460	81,55%
EAST JAVA	2.349.000	433.246.443.929	66,23%	2.349.000	477.384.661.428	66,23%	2.381.254	485.175.965.820	67,14%
JAVA	**6.508.000**	**631.309.138.997**	**39,97%**	**6.508.000**	**836.529.536.577**	**39,97%**	**6.177.915**	**847.186.830.065**	**37,94%**

*MS = Market Share

5. Volume flow in to packing plant = volume flow out from packing plant to area sales

$$\sum_{f=1}^{F}\sum_{p=1}^{P}\sum_{t=1}^{T}\sum_{j=1}^{J} XI_{pftj} - XPP_{dptj} \leq 0 \quad \forall f \forall p \forall t \forall j \tag{9}$$

This constrains guarante that the flow in volume from the factory to the packing plant is as same as the flow out volume from the packing plant to the area sales

6. Volume fullfillment of demand Y_{dtjk} area sales based on market share policy based on equation.

$$(M_d + KMin_{dk})Y_{dtj} \leq Y_{dtjk} \leq (M_d + KMax_{dk})Y_{dtj} \quad \forall t \forall j \forall k \tag{10}$$

So we have upper bound and lower bound for the demand to be delivered

a. Volume to area sales ≤ upper bound of demand based on market share policy

Table 9.
The Distribution Facilitie Utilization

Product	Utilization	Tuban	Rembang	Narogong	Banyuwangi	Gresik	Priok	Ciwandan
OPC	Inbound	33.100	-	-	-	-	-	-
	Outbound	4.959.900	564.700	906.600	-	-	16.900	16.200
	Total OPC	4.993.000	564.700	906.600	-	-	16.900	16.200
	Capacity OPC	5.475.000	1.825.000	912.500	-	730.000	912.500	912.500
	% Utilization OPC	**91,20%**	**30,94%**	**99,35%**	**0,00%**	**0,00%**	**1,85%**	**1,78%**
PCC	Inbound	27.000	-	-	-	-	-	-
	Outbound	4.100	5.300	-	27.000	7.300	-	-
	Total PCC	31.100	5.300	-	27.000	7.300	-	-
	Capacity PCC	3.650.000	3.650.000	-	912.500	182.500	-	912.500
	% Utilization PCC	**0,85%**	**0,15%**	**0,00%**	**2,96%**	**4,00%**	**0,00%**	**0,00%**
Total	Inbound	60.100	-	-	-	-	-	-
	Outbound	4.964.000	570.000	906.600	27.000	7.300	16.900	16.200
	Total Cement	5.024.100	570.000	906.600	27.000	7.300	16.900	16.200
	Capacity Cement	9.125.000	5.475.000	912.500	912.500	912.500	912.500	1.825.000
	% Utilization Cement	**55,06%**	**10,41%**	**99,35%**	**2,96%**	**0,80%**	**1,85%**	**0,89%**

$$\sum_{d=1}^{D}\sum_{f=1}^{F}\sum_{t=1}^{T}\sum_{j=1}^{J}(XFT_{dftj}+XFN_{dftj})+\sum_{d=1}^{D}\sum_{p=1}^{P}\sum_{t=1}^{T}\sum_{j=1}^{J}XPP_{dptj}+\sum_{d=1}^{D}\sum_{g=1}^{G}\sum_{t=1}^{T}\sum_{j=1}^{J}XGP_{dgtj}\le(M_d+KMax_{dk})Y_{dtj} \quad (11)$$

This constrain can limit the fulfill of the demand volume at the maximum of the upper bound value based on the market share policy of the company

b. Volume to area sales ≥ lower bound of demand based on market share policy

$$\sum_{d=1}^{D}\sum_{f=1}^{F}\sum_{t=1}^{T}\sum_{j=1}^{J}(XFT_{dftj}+XFN_{dftj})+\sum_{d=1}^{D}\sum_{p=1}^{P}\sum_{t=1}^{T}\sum_{j=1}^{J}XPP_{dptj}+\sum_{d=1}^{D}\sum_{g=1}^{G}\sum_{t=1}^{T}\sum_{j=1}^{J}XGP_{dgtj}\ge(M_d+KMin_{dk})Y_{dtj}$$

(12)

This constrain can limit the fulfill of the demand volume at the minimum of the lower bound value based on the market share policy of the company

7. Non-negativity

$$CPP_{ptj},CFN_{ftj},CFT_{ftj},CGP_{gtj},M_d,Y_{dtj},Y_{dtjk},KMax_{dk},HT_{dtjf/p/g},BC_{dtjf/p/g},BM_{dtjf/p/g},BO_{dtjf/p/g},BA_{dtjf/p/g},XFN_{dtjf},XFT_{dtjf},XPP_{dtjp},XGP_{dtjg},XI_{tjf}\ge 0 \quad (13)$$

IV. CASE LOCATION ALLOCATION OF DISTRIBUTION NETWORK

An Indonesia cement company has make a bussiness acquisition policy of a similiar company. After the acquisition, Indonesian cement company has 5 cement factory, 3 packing plant, 1 grinding plant as the distribution facilities to fulfill cement demand in Java. As Figure 3 show that the company distribution facilities has covered all provinces in Java.

For bulk cement distribution facilities, the company has 3 factory (Tuban, Rembang, and Narogong), 3 packing plant (Banyuwangi, Priok, and Ciwandan), and 1 grinding plant (Gresik) for fulfilling bulk cement demand in Java. And it has two type of bulk cement, OPC and PCC. There are 103 sales area in 5 province in Java with demand volumes estimated about 6,5 million tons a year. Therefore, the company need to develop new location allocation of the distribution network to satisfy the market demand and also to strengthen the market share for achieving the maximum operating income.

C. Data

The data parameter taken from the company shown in Table 1 to Table 5.

D. Result and Discussion

The model run using Open Solver software which a Microsoft Excel 2013 addon in Intel (R) Core (TM) i5-5200U CPU @ 2.20 GHz (4 CPUs) RAM 8.192 GB, experimental firstly calculate the operating income for each plant-destination (Table 6) and setup the lower and upper boundary of the market share policy (Table 7).

After that we setup the contraint in the open solver software. And then we run the Open Solver and get the objective function result presented in Table 8. The Table 8 shows that the operating income tend to higher when the model processed. In scenario all demand will be fulfilled, the operating income had 32,51% higher than the expected value with the same market share. And more higher 34,20% than expected value when the model run with the scenario using market share policy. However, there are decreased volume and declined market share when the model run with scenario market share policy, but it is still within the boundary of the market share policy. This indicate that the model tend to increase the volume that have higher operating income and decrease the volume that have the lower or negative operating income. This shows that the model can effectively conduct location allocation on the distribution network that generate optimal operating income with considering the market share policy.

The distribution facilities utilization is also measured to check wether the distribution facilities utilized properly or not. Table 9 shows that there are no over utilized or no over capacity of the distribution facilities. The new distribution facilities (Narogong Factory) become crucial for the Indonesia cement company with 99,35% of utilization to support the company for distributing the product to the customer and help the company to generate higher operating income.

V. CONCLUSION AND FUTURE RESEARCH

The location allocation of the distribution network plays crucial role in supply chain management. Because of bussiness acquisition policy of a similliar company, a supply chain manager must be able to develop new location allocation model of the distribution network to optimilize the distribution allocation of the product to achieve maximum operating income for the company and also to satisfy the demand for maintain the market share according to company market share policies. The model using linear programming with two scenario to show the model behaviour towards demand fulfillment based on market share policy, location allocation model of the distribution network can be constructed respect to demand fulfillment at each of the distribution network, distribution facilities capacity, and the market share policy. The optimization result reached optimum condition and shows that all demand satisfied from the distribution facilities at maximum operating income and acceptable market share value based on market share policy. As the higher operating income, the higher volume will be allocated. And conversely as the lower operating income, the smaller volume will be allocated. However, the model still can developed in the future research by considering wether the company will keep or release the distribution facilities, the other financial measurement, or others company policies other than market share policy.

REFERENCE

[1] D. Simchi-Levi, P. Kaminski, and E. Simchi-Levi, *Designing and Managing The Supply Chain: Concepts, Strategies and Case Studies*, 3rd ed. Mc Graw Hill, 2008.

[2] I. N. Pujawan and E. Mahendrawathi, “Supply Chain Management, Surabaya.” Guna Widya Press, 2005.

[3] S. Chopra and P. Meindl, *Supply Chain Management Strategy, Planning, And Operation*, 5th ed. Prentice Hal, Inc, 2013.

[4] P. Tsiakis and G. Papageorgiou, “Optimal Production Allocation and Distribution Suppy Chain Networks,” *Int. J. Prod. Econ.*, vol. 111, no. 2, pp. 468–483, 2008.

[5] A. Ahmadi-Javid and N. Azad, “Incorporating location, routing and inventory decisions in supply chain network design,” *Transp. Res. Part E*, vol. 46, no. 5, pp. 582–597, 2010.

[6] J. Brimberg and P. Hansen, “Improvements and Comparison of Heuristics for Solving the Uncapacitated Multisource Weber Problem,” *Oper. Res.*, vol. 48, no. 3, pp. 444–460, 1999.

[7] M. Daskin and L. V. Snyder, “Facility Location in Supply Chain Design in Logistics Systems: Design and Optimization,” United Stated of America, 2005.

[8] J. Current, “Multiobjective analysis of facility location decisions,” *Eur. J. Oper. Res.*, vol. 49, pp. 295 – 307, 1990.

[9] A. Lwin, I. Pujawan, and I. K. Gunarta, “The design of cement distribution network in Myanmar : a case study of ”X” cement industry,” in *Prosiding Seminar Nasional Manajemen Teknologi XXIII*, 2015.

[10] A. Ahmadi-Javid and P. Hoseinpour, “Incorporating location, inventory and price decisions into a supply chain distribution network design problem,” *Comput. Oper. Res.*, vol. 56, pp. 110–119, 2015.

[11] F. Prabowo, “Optimasi pencapaian EBITDA dengan penerapan strategi alokasi distribusi market share di PT. XYZ,” Surabaya, 2017.

[12] C. van Dijk, “Profit Optimization in Express Networks,” 2018.