Goal Prgramming Approach in Determining Production and Delivery Decision from Two Factories

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Abstract—**Nowadays, the consumer goods industry is increasing rapidly due to several factors including market expansion, increasing number of producers, increasing competition, and high customer demands. Implementing the right production and shipping decision strategy is also very important in order to achieve the proper distribution function, efficiency, and profits received by the company. The development of retailer business in Eastern Indonesia of PT XYZ, cooking oil and branded vegetable fats food producer, especially the South Sulawesi area since 2017 to 2019 in modern trade category experienced quite high growth. However, due to product limitation constraints and delivery routes at Bitung factory, 82% supply was from Surabaya factory even though geographically Bitung factory is closer. Product variation limitations that cannot meet customer orders causes the non optimal goods expenditure from the Bitung factory, so the Bitung factory utility is very low. Longer shipping time via Surabaya factory often cause goods delay at the store resulting loss in sales volume and cash to cash cycle periods which is quite a time. Increased utilization of the Bitung factory, flexibility in ordering products, and shortened delivery speed pushed PT XYZ to optimize the Bitung factory expenditure through meeting sales targets of the South Sulawesi area by establishing a buffer warehouse in Makassar that serves as a transfer product loads consolidation of the Bitung factory and Surabaya factory to the point delivery destinations via land to customers in South Sulawesi Province. With the goal programming modeling method, the optimal transfer consolidation quantity from the two factories that can be removed from the Bitung factory is 1,831,312 cartons and the Surabaya Factory for products not produced from the Bitung factory is 158,105 cartons which then distributed through the buffer warehouse. Therefore, the expenditure of this amount will increase the utility capacity of handok machines in Bitung factory to 45% and canning machines to 12%. Sales target in South Sulawesi Area can reach 98.47% and 15% growth compared to last year. Faster delivery will be 10 to 14 days and cash to cash cyvle become 23 to 27 days**.

Keywords—**Buffer Warehouse, Cooking Oil, Distribution, Goal Programming, Optimization of Production.**

I. INTRODUCTION

THE challenge of the manufacturing industry in supplying goods to their customers is changing. Since the proliferation of modern retail in Indonesia, sales competition, and pressure to maintain market share is increasingly heavy, and customer demand is increasing. Demands for service levels (quality, delivery speed, and conversions) and sales targets are two things that suppliers must implement to win the market. Aquilano et al. (1995) propose three main strategies: low cost, high quality, and responsiveness (delivery time and product delivery flexibility). This shows that producers can no longer maintain large production volumes, thus increasing production costs and efficiency to compete in the market (Duclos et al., 2003). One strategy for gaining and maintaining excellence in a dynamic environment is by creating a flexible organization (Sanchez, 1995).

PT. XYZ is a food producer which specialized in branded cooking oils and fats in Indonesia. Their regional sales are divided into four areas with five refineries (Lubuk Pakam, Pluit, Tanjung Priok, Tanjung Perak and Bitung). Average monthly sales for Eastern Indonesia (Sulawesi, Papua and Maluku) from 2017 until 2019 is 6,450 tons with 40% contribution from South Sulawesi area to the total East Indonesia turnover in 2019.

All Sulawesi customers are supplied by Tanjung Perak (Surabaya) and Bitung (Manado) factories. The shipments contribution from Bitung based on the area that can be supplied is only 30% for all 2019 sales categories while the shipments contribution to the South Sulawesi area from the Bitung Factory is only 18%. The majority of customer shipments in South Sulawesi area are sent from Surabaya. The low shipments frequency from Bitung is due to; **(1)**Limited variety of products and shipping routes;**(2)**Limited production capacity; (3)Variations in customer orders that make unoptimal expenditure.

This has caused 44% handock machines utilities and 11% canning machine utilities for the last two years. Since customer requests cannot be fulfilled, shipments need to be diverted to Surabaya factor. The transferring shipments process raises a new problem, the long delivery time with estimated arrival of 14-21 days after the customer issues a purchase order.

Based on Figure 1, the whole process from ordering to receiving payment ideally takes 40 to 47 days, but unpredictable field conditions such as shipping delay, vessel limitations, dooring or unloading queues, and goods receipt delay resulting in late invoice exchange process so payments are made 2 to 3 months later. This will cause a long account receivable days and affect the company's cash to cash.

Receiving cooking oil on time is an important factor in winning market competition. Optimization of distribution and availability of stock aims to maintain market share and avoiding the possible competitors. However, customers have limited warehouse capacity and information systems that cannot be known at any time by suppliers. To solve the
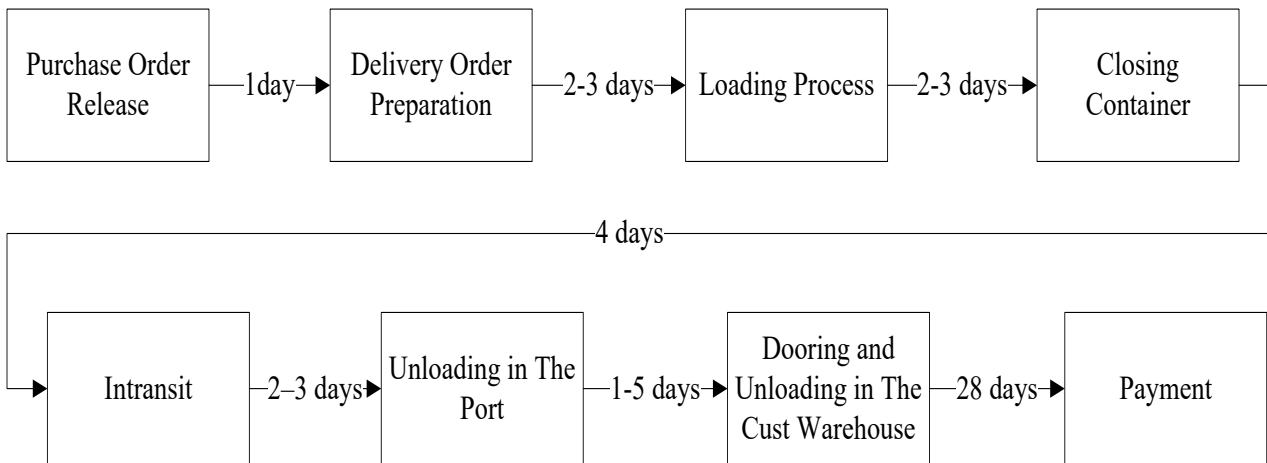
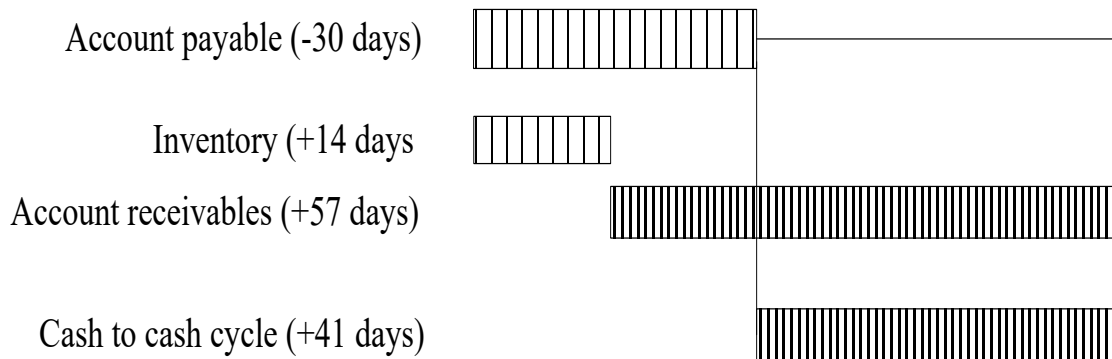Figure 1. Goods Delivery Route Surabaya - South Sulawesi.

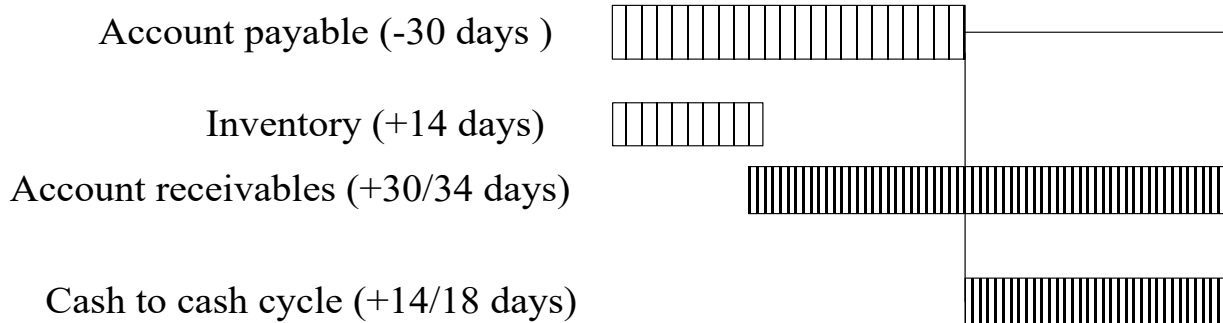Figure 2. Cash to Cash Cycle of South Sulawesi Customers in 2019.

Figure 3. Cash to Cash Cycle of South Sulawesi Customers with a Buffer Warehouse.

distribution and sales problem on Sulawesi, Makassar has been chosen as the location of the buffer warehouse by the company because;(a)The sales volume in South Sulawesi area is 73% of the total sales in Sulawesi based on 2019 data; (b)The total shipping destinations for all sales channels in South Sulawesi province are the most compared to other provinces; (c)Makassar Port is the largest port and intransit port for others on Sulawesi; (d)The presence of SAP networks in interbranch companies that can be used to support information flow; (E)The goal of optimizing the Bitung factory is to reach regional sales in Eastern Indonesia and shorten the delivery period from Bitung to Makassar.

Optimization with Goal Programming (GP) method is used to maximize the expenditure of the Bitung factory and minimize costs, and subsequently analyze and evaluate data generated. This method is an extension of the linear programming model. It is a way to solve the problem by allocating limited resources such as labor, raw materials, working hours, machines and so on in the best possible way to obtain a maximization that can be in the form of profit maximization or maximization that can be in the form of minimization of costs (Papadomanolakis & Ailamaki, 2007).

II. METHOD

The study was conducted with the following stages:

A. Conceptual Diagram Making;

To identify the main problem in this study, researchers conducted observations of sales conditions in Sulawesi sales area and discussions with internal parties related. The root of the problem is limited production capacity and transportation of the Bitung factory in fulfilling the highest sales target in Sulawesi area, especially the South Sulawesi area.

Table 1.
Output Data of Goal Programming Approach for Bitung Factory Goods Spending

Product	Bitung Factory Total Output (carton)	Machine Utility
1 litre pouch packaging A brand;	276.815	
2 litre pouch packaging A brand;	1.325.863	97%
5 litre jerrycan packaging A brand;	228.634	23%

Table 2.
Output Results of Total Shipment from the Factory to the Buffer Warehouse

Factory	Total Shipment
Surabaya	171
Bitung	1.282

Table 3.
Output Results of Shipment Amounts from Buffer Warehouses to the Market

Market Point	Total Shipment
Makassar	5.567
Pare Pare	1.131
Palopo	887
Bulukumba	550
Bone	522
Toraja	194
Mamuju	139
Mangkutana	104
Sopeng	116
Belopa	82

Table 4.
Total Product Sales Revenue

Product	Delivery Quantity to Market Points
1 litre pouch packaging A brand;	276,815
2 litre pouch packaging A brand;	1,325,863
5 litre jerrycan packaging A brand;	228,634
2 litre pouch packaging B brand;	119,743
1 litre pouch packaging B brand;	80,415
5 litre jerrycan packaging B brand;	38,362

Table 5.
Payment Data and Operational Profit Calculation of Bitung Factory Operational (in million)

Description	2019	2020 Estimation
Revenue	209.698	381.347
COGS (Cost of Goods Sold)	189.180	250.483
Gross Profit	20.516	130.864
Operating Expenses	31.743	30.818
Warehouse Expenses	-	759
Freight Cost	-	15.001
Profit/(Loss) before Tax	**(11.227)**	**84.284**

Optimizing the sales target of the research object, customers in South Sulawesi, requires a production and delivery decision approach from two factories, the Surabaya factory and the Bitung factory.

B. Data Collection

1) Data collected in this research are:

a. Sales data on South Sulawesi area from 2017 to 2019.
b. AOP (Annual Operation Planning) 2020.
c. Production capacity data of Bitung factory.
d. Data on shipping costs of containers and trucks for each point of shipment.
e. Data on product selling prices and production operations.
f. Data on product volume and weight.

C. Goal Programming Model Development

The formulation of this model is to determine the estimated goods expenditure in Bitung and the profits projection for the next one year.
Notation:
i = product (1,2,…,6);
j = factory (1/Surabaya,2/Bitung);
l = delivery point (1,2,…,10);
t = selling period (1,…,4);
Parameter:

D_{ilt} = i product demand for l delivery point on t period (carton)

$m1_t$ = Bitung factory handock machine capacity on t period (*pouch*);

$m2_t$ = Bitung factory canning machine capacity on t period (*jerry can*);

u_l = standard order quantity of the load to l delivery point (kg);

u_j = standard order quantity from j factory to *the warehouse* (m³);

K = warehouse capacity (carton);

V_i = i product value (m³);

W_i = i product net weight (kg);

C_l^T = delivery cost to l delivery point using truck (Idr/shipment);

C_j^C = delivery cost from j factory to the warehouse using container (Idr/*shipment*);

C_j^{HPP} = cost of goods sold from j factory (Idr/kg);

C_j^{OEP} = Bitung factory annual operating cost(/year);

C_K = buffer warehouse annual operating cost (Idr/year);

H_i = i product selling price (Idr);

$GOAL_P$ = desired annual profit (Idr);

$GOAL_X$ = desired exprenditure from Bitung factory (carton);

Decision variable:

X_{ijt} = i product quantity sent from j factory to buffer warehouse on t period (carton);

Q_{ilt} = i product quantity sent from warehouse to l market route on t period (carton);

S_{it} = i product supply on the warehouse on t period (carton);

N_{lt} = number of shipping shipments to l market routes on t period;

N_{jt} = number of shipping shipments from j factory to the warehouse on t period;

d_P^+ = deviation value above $GOAL_P$;

d_P^- = deviation value below $GOAL_P$;

d_X^+ = deviation value above $GOAL_X$;

d_X^- = deviation value below $GOAL_X$;

The goal model formulation is to determine the expenditure of goods produced by the Bitung factory and optimal company profits obtained.

$$\sum_{t=1,\ldots,12}(X_{12t} \times W_{12t} + X_{22t} \times W_{22t} + X_{32t} \times W_{12t}) - d_x^+ + d_x^- = GOAL_X \quad (1)$$

$$\left[\sum_t \sum_l \sum_i (H_i \times Q_{ilt}) - \left\{\sum_t \sum_j \sum_i (X_{ijt} \times W_i^N \times C_j^{HPP}) + \sum_t \sum_l (N_{lt} \times C_l^T \times 5) + \sum_t \sum_j (N_{lt} \times C_j^T) + \sum_{j=1,2} C_j^{OEP} + C_K^{OEP} + C_K^T\right\}\right] - d_p^+ + d_p^- = GOAL_P \quad (2)$$

$$M_i = \{0,5d_X^- + 0,5d_P^-\} \quad (3)$$

Constraints:

1. The product sent to the buffer warehouse is smaller than the production machine capacity at factory 2 for products 1 and 2.

$$12 \times X_{12t} + 6 \times X_{22t} \le m1_t \quad (4)$$

2. The product sent to the buffer warehouse is smaller than the production machine capacity at factory 2 for product 3.

$$4 \times X_{32t} \le m2_t \quad (5)$$

3. Products sent to the market are smaller than market demand.

$$Q_{ilt} \le D_{ilt} \quad (6)$$

4. Stock level in the buffer warehouse.

$$S_{it} = S_{i(t-1)} + X_{ijt} - Q_{ilt} \quad (7)$$

5. The quantity position in the buffer warehouse is less than the buffer warehouse capacity.

$$\sum_i S_{it} \le K \quad (8)$$

6. Shipment transfer process from the factory to the warehouse or from the warehouse to the market must in accordance to the MOQ (minimum order quantity).

$$0,97 \times u_j \ge \frac{\sum_i (V_i \times X_{ijt})}{N_{jt}} \le u_j \quad (9)$$

$$0,97 \times u_l \ge \frac{\sum_i (V_l \times Q_{ijt})}{N_{lt}} \le u_l \quad (10)$$

7. Bitung Factory only transfer product 1, 2, and 3 and Surabaya Factory only transfer product 4, 5, and 6 because no capacity

$$X_{11t} + X_{21t} + X_{31t} + X_{42t} + X_{52t} + X_{62t} = 0 \quad (11)$$

8. All decision variables are integer.

$$X_{ijt}, Q_{ilt}, S_{it}, N_{jt}, N_{lt} \ge 0 \text{ and integer} \quad (12)$$

The next method are translation formulation and optimization process with LINGO software.

III. RESULT AND DISCUSSION

From the previous data processing, the Bitung factory (the second factory) maximum quantity is 1.814.712 carton, and handok machine utility (the first machine) and canning machine utility as Table 1.

With the goal programming modeling method, the optimal transfer quantity that can be released from the Bitung Factory is 21,005.6 tons and the increasing utility of handok machines in the Bitung factory is 45% and canning machines is 12% than average three years ago. We have to new strategy to increase volume canning machine with market penetration so the demand of the market growth and we can produce the product more optimal in the Bitung factory.

Assuming there is no change in the shipping container cost for all points of interest, the distribution data are as follows:

a. The transfer process inbound from factory 1 and 2 to the buffer warehouse: The product transfer inbound to the buffer warehouses of each factory in 2020 can be seen in the table 2:

This data is useful when we submit canvas sheets to the expedition vendors.

b. Shipping outbound data from the customer's warehouse to marketing points:

Shipping outbound data to each marketing point can be seen in the table 3.So, the average outbound shipment per kuartal is 2.323 units. From the distribution process, the total revenue from product sales to all market points is as Table 4. Based on the data above, the total sales revenue is IDR 381,347,141,952. And then the profit and lost analysis are presented in the table 5.

From the table 5, an increase in profit before tax is IDR 84,284,404,61. Based on the profit gained, the tax imposed are 25%. Thus, the net profit is IDR 63,213,303,459.

The profit gained is greater than the management installed target. However, these have not been reduced by the cost of promotion carried out by the marketing department and the initial inventory value. One of the promotional costs is used for market penetration if the actual order is less than the specified sales target and the amount is adjusted to the funds owned by the company at that time.

If the same analysis is carried out with a different distribution model compared to the condition 3 years ago, a distribution model with loading consolidation in a feasible buffer warehouse is carried out and the company makes a significant profit. The machine utility in Bitung factory can be more optimal and efficient in its operational activities. Additional distribution and warehouse investment costs can still be covered by the sales value obtained. On the other hand, in addition to sales targets that reflect the field condition, the smooth delivery and the release of goods to become a company turnover are influenced by the timely arrival of transfer stock from both factories (just in time) at the buffer warehouse. Constraints in the factory or transfer process will affect the stock in a buffer warehouse and delivery time to the customer.

As cooking oil is a major commodity product, the company applies a make to stock mechanism in the factory, especially the six products mentioned in this study. Besides that, it is necessary to maintain communication and quality so the inbound and outbound processes can run well. One example is anticipating damaged goods due to the loading and unloading process twice. If there is damage, then profit will decrease. Delay and mismatch in order delivery will reduce service level. Therefore the basic priorities of competition and company capability must be maintained. Price, quality, time, and flexibility are four important priorities in carrying out market and supply chain strategies.

Financially, the establishment of a buffer warehouse is increasing the profits of the Bitung factory and internal companies, especially the East Indonesia regional sales. Another benefit is the improved customer cash to cash cycle. Delivery via the buffer warehouse in Makassar will speed up

the process of receiving orders so the invoice exchange process will be faster too. This has a positive impact on the condition of the customer's receivable account. Costs for running working capital that are retained during the cash to cash cycle return faster so it can be immediately used by the company.

Before the establishment of buffer warehouse, the condition of cash to cash cycle can be seen in Figure 1. In general, the cash to cash cycle image of Surabaya factory or Bitung factory for direct shipping, especially modern trade accounts with goods arriving in 17 days in the Makassar area, and assuming the dooring time is 5 days, term of payment 28 days and payment schedule +/- 7 days is as Figure 2.

However, with the existence of buffer warehouse, account receivable can be reduced to 30 to 34 days, taking into account the length of time for intransit or delivery of customer areas in South Sulawesi Province (1 to 3 days), receipt of documents of receipt of goods (1 to 3 days), and term of payment (28 days). An illustration of the estimated cash to cash cycle in the presence of a buffer warehouse is as figure 3.

The value obtained can be considered as the best value in the industry that engaged in packaging goods. The benchmarking study results of 100 participants from the Cash-to-Cash journal: the new supply chain management matrix (Farris & Hutchison, 2002), C2C for the packaging goods category manufacturing industry is 24 days. The C2C value obtained in this study is in a form of distribution flexibility proposed to the company by shipping via a buffer warehouse

Evaluation from market competition side, delivery lead time from the date of purchase order issued will be shorter i.e 10 - 14 if the inventory and process of goods replenishment in the warehouse are properly maintained, thus the opportunity for goods arrival is more in time. In addition, shipping via land is faster and easier with shipping time flexibility than shipping by ocean freight forwarding. The load consolidation process becomes more flexible and more aggregated deliveries give advantage for customers and the suppliers' service level target to fulfill customer orders to the fullest. Considering that cooking oil is a commodity of daily necessities, availability in store factor is very important so that market share is maintained, which close the possibility of competitors entering. With the retailer customer that has limited warehouse capacity and point of sales information system that cannot be updated at any time by suppliers, the establishment of a buffer warehouse is expected to be able to consistently fill product availability which is one of the sales strategies.

decision and shipping of the Bitung factory and Surabaya, total goods expenditure obtained at the Bitung factory is 1,831,312 cartons. This increasing the handok machines capacity in Bitung factory to 97% and canning machines to 23%. From the production operational side, the goods expenditures distribution from both factories for the South Sulawesi market are able to meet the profit target and increase 602% of profit for the Bitung factory compared to 2019. Therefore, the qualitative performance advantage of buffer warehouse establishment is faster order response due to shorter lead times and the quantitative performance advantage for company is shorter receivable accounts so customer receivable payments can be faster. Changing the product distribution strategy model through a buffer warehouse with a location close to the market, the product marketing position becomes more competitive in terms of quality, time, and flexibility which has a very strong impact on sales or supply chain costs.

Some proposed managerial implications are to achieve the optimal sales and goods expenditure target at the Bitung factory so that the profit and service level obtained can be maximized, the company is expected to be able to coordinate demand management and production planning properly. Demand management can be done through promotional activities, shelf management by placing goods at eye level positions, and conducting profitable terms for the company. Given the very short inventory days of supply to meet sales targets, the existing stock in Bitung must always be maintained. This can be done by maximizing the capacity and inventory of finished goods warehouses in Bitung factory. The process of transfer and delivery to the market must also be scheduled so that it is necessary to coordinate with expedition vendors. In support of the CRP (Cost Reduction Program), a solution is needed for maximum the utilization of Bitung factory canning machine. One solution is by looking for new markets or customers and marketing strategies to surpass competitors so it can be more competitive . Since, the optimization of the product 3 is still low due to the demand, it is necessary to reconsider the operator's working hours or the number of contract workers needed in an effective work period so sales and operation planning can be measured. With the establishment of a buffer warehouse closer to the market, it is necessary to reconsider the term of payment (TOP) which should be distinguished from TOP direct shipping from Surabaya or Bitung. The term of payment deal to the customer can be discussed beforehand but this decision does not affect the buyer's decision to keep purchasing the goods. The lower the TOP the shorter the receivable account, the faster working capital will return.

IV. CONCLUSION AND MANAGERIAL IMPLICATION

Based on the results of the analysis and discussion, the goal programming method is one of the multi-objective solution methods that is able to provide solutions based on the desired target for operational and distribution problems faced by PT XYZ. From the optimization results with the goal programming model approach to the shipping production

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