Determination of Joint Lot Size using the supply chain approach with Vendor Managed Inventory (VMI) Method at PT. XYZ

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Abstract. PT. XYZ is a company producing animal feed products which is located in the Medan Region. This company is a branch of Z Group company based in Surabaya. In the process company business activities, both from the process of ordering raw materials to suppliers up to the sale of products to buyers, often happens planning mismatches in determining production lots so often cause overstock and stockout. This is based on the lack of integration each component in the supply chain. Each component is still using the traditional way that is by making each plan without coordinating with each other. This manufacturing company still needs to do improvements in the production planning system. The absence of the PPIC Department make planning in the production in the company becomes out of control. This study aims to improve the supply chain system by method VMI and determine the optimum combined lot size by the JELS method. The JELS calculation results show an optimal Q of 8,692 bags, with QM for 437,082 bags with a frequency of product shipments 50 times and the frequency of replenishment of raw materials 13 times.

1. Introduction
PT. XYZ is a company engaged in feed production live stock. The main product of the company is chicken feed, whereas as Supporting products are animal feed for pigs, cattle, goats, ducks, and fish. In the company's operational processes meet the demand with the Pull method demand system, which is a demand fulfillment system by considering external conditions or in other words demand is determined by consumers themselves. The advantage of this system is that the company can recognize changes that occurs in the external environment and can make policies for anticipating these changes. But in reality, the demand is must be met always uncertain and cause difficulties in determine the production lot size policy. Lack of information can be cause chaos in the supply chain.

ISA 105 (Mash) is the most abundant product and significantly produced by PT. XYZ compared to 35 other types of feed products and is make to stock so that sometimes it can cause build up product (over stock) or product shortage (stock out) when planning not accurate. There are other types of feed products that are made to order, such as feed products for cows, ducks, pigs, and so on. Supply chain system for layer 105 chicken (Mash) chicken feed products at PT. XYZ-Medan Mill can be seen in Figure 1.
Figure 1. shows the supply chain system of layer chicken feed products 105 ISA (Mash). The raw material comes from an importer company, PT. FKS Indonesia, a single company importing corn raw materials for the region North Sumatra. The company meets the material requirements according to the arrival of imported materials from abroad and the request from the factory need imported raw materials. Receiving raw materials cannot be done directly at the time of order. The buyer must at least waited for a month because the product was imported from abroad the shipping process takes quite a long time. Therefore, parties feed producers must be able to plan exactly when the raw material ordered and available when needed so that the production process can run smoothly and can meet the amount of demand for feed products by consumers. The demand for feed products is done by Sri companies Winarti (SW) and Bak Tjai (BT) through the sales department at PT. XYZ-Medan Mill which will then be processed in the production section. On Figure 1. It can also be seen that manufacturers and buyers of feed products determine each lot size for. This is why it is not integrated feed product supply chain system 105 ISA (Mash). Planning done often not in accordance with the reality that occurs in the field so causing the number of products produced is not optimum.

Based on the company's previous supply chain picture, it was also found data on the number of requests, the amount of production, and the amount of supply of feed products 105 ISA (Mash) for the period September 2017 - August 2018 which can be seen in Table 1.

| Period          | Number of Requests (Bags) | Total Requests |
|-----------------|---------------------------|----------------|
|                 | SW (Bags)                 | BT (Bags)       |                  |
| September, 2017 | 21.355                    | 9.426           | 30.781           |
| October, 2017   | 25.241                    | 9.076           | 34.317           |
| November, 2017  | 23.628                    | 11.662          | 35.290           |
| December, 2017  | 21.175                    | 11.166          | 32.341           |
| January, 2018   | 24.946                    | 11.538          | 36.484           |
| February 2018   | 27.215                    | 9.935           | 37.150           |
| March., 2018    | 26.844                    | 11.039          | 37.883           |
| April, 2018     | 24.249                    | 10.775          | 35.024           |
Table 1. shows that there are different differences and lead to product accumulation (over stock) in the period September 2017, October 2017, December 2017, April 2018, May 2018, and June 2018 as well product shortages (stock out) in the period November 2017, January 2018, February 2018, March 2018, July 2018 and August 2018. From observations at company, the occurrence of overstock and stock out is caused by a demand tend to change and the absence of special sections or departments for production and inventory planning in determining lot orders clearly between suppliers, companies and buyers. Companies and buyers respectively plan their own needs and supplies, so the difference planning often happens. Stacking of product inventory in the product warehouse will pose an expiration risk, because feed products are products perishable. But if the company cannot meet the number of products in accordance with the request of the buyer, it will lead to lost sales. Of course these things will cause risks, both cost and integrity between companies.

2. Literature Review
2.1. Supply Chain Concept
Supply chain may have often been heard. In Indonesian often found translation of the supply chain as “procurement chain or supply or supply of goods and services”. Basically supply chain is a network of organizations involving upstream and downstream relations (upstream-downstream), in different processes and activities, which generate tangible value in goods and services in the hands of users or final consumer. The different processes and activities involve relations between actors, from producers or suppliers, makers or processor, distributor or distributor to the user or consumer [1].

According to NyomanPujawan [2], Supply chain is a network companies that jointly work to create and deliver a product to the end user. Companies These usually include suppliers, factories, distributors, stores or retail, as well supporting companies such as logistics service companies.

The concept of supply chain is a new concept in looking at the problem internal logistics. The old concept sees logistics more as an internal problem each company and its solution is focused on solving internally in their respective companies. In this new concept, a problem logistics is seen as a broader problem that stretches very long from basic materials to finished goods used by end consumers, which is a supply chain. Seeing this definition, you can it is said that the supply chain is a logistics network. In this supply chain there is a supply chain, also called "model four step "(the four step model), which consists of elements, [1] that is:

a. Suppliers
b. Manufacturers
c. Distributors
d. Retailers

According to Indrajit [1], key factors are managed in supply chain includes:

a. Management of relationships with consumers.
b. Management of services to consumers.
c. Demand management system.
d. Manufacturing flow regulation system.
e. Raw material procurement system (Office Stationery).
f. Development of commercial products and processes.
g. Product return

In a supply chain there are usually 3 types of flow that must be managed. First is the flow of goods that flows from upstream to downstream. Examples are raw materials sent from suppliers to parts logistics. After the raw materials are finished producing, they are sent to the distributor, then to retailers or retailers, then to end users. The second is flow money and the like that flows from downstream to upstream. The third is flow information that can occur from upstream to downstream or vice versa.
Information about inventory of products that still exist in each division often needed by distributors and by agencies. Information about availability production capacity owned by the supplier is also often needed by agency. Information about the delivery status of raw materials is often needed by the sending and receiving agency. Shipping agencies must share information like this so stakeholders can monitor in the interest of more accurate planning. Figure 2 gives conceptual illustration of a supply chain.

![Supply Chain Diagram](image)

**Figure 2.** Simplification of Supply Chain Models and 3 Kinds of Flow Managed

### 2.2. Supply Chain Strategy

According to Chopra [3], supply chain strategies are needed to help achievement of the desired agency goals in the agency strategy. To be able to Win the market competition, there are 3 stages that must be carried out including:

a. Institutions must understand the needs of consumers in each market segment.

b. Agencies must understand the designed supply chain.

c. The agency has the ability to change the structure of the supply chain if there is a mismatch between the supply chain design with the desire consumer.

### 2.3. Supply Chain Management (SCM)

The term SCM was first coined by Oliver & Weber in years 1982. If the supply chain is the physical network, i.e. companies involved in supplying raw materials, producing goods, as well as send it to end users, SCM is a method, tool, or approach its management. But it should be stressed that SCM requires an approach or integrated method based on the spirit of collaboration [4][5].

### 3. Research Method

#### 3.1. Type of Research

This type of research is action research. Action research is a research conducted for get practical findings / for decision making purposes operational (Sinulingga, 2011) [6]. Because the goal is for decision making operational to develop new skills or new approaches then This research contributes less to science

#### 3.2. Object of research

The research object observed was the number of animal feed products 105ISA (Mash) is produced and will be sent to buyers who are partners company business namely X1 and X2 by considering defective products and backorder in the supply chain network with a single supplier, costs, as well inventory and information systems for implementing Supply Chain Management.
3.3. Variable Research
A. Independent variables, namely:
   a. Number of requests, number of products ordered by customers per unit time
   b. Message Fee, i.e. the amount of money that must be spent for support product ordering activities. In this case the cost of the message consists of the two indicators namely the cost of ordering raw materials by manufacturing and cost of ordering finished products by the customer.
   c. Save Cost, i.e. the amount of money that must be sacrificed for support storage activities. In this case the cost of the message consists of several indicators namely the cost of storing raw materials, the cost of storing products so by manufacturing, the cost of storing the finished product by the customer.

B. Dependent variable, which is the optimum economic lot size (Joint Economic Lot Size).

3.4. Method of Collecting Data
In this study the data collection techniques used were in the form of:
1. Interview techniques, namely by conducting interviews with parties’ company management to get the information needed in order achievement of research objectives.
2. Observation technique, which is to recapitulate stock level and demand in the current period of the product 105 ISA Mash.

4 Result and discussion
4.1 Supply Chain Analysis System Based on the Vendor Method Managed Inventory (VMI)
Supply chain systems with vendor managed inventory methods are used to determine new policies by determining economically optimal lots for both parties. Then do a good integration of the suppliers, manufacturers and distributors will increasingly influence the smooth flow system. One of the supply chain integration policies is implementing the vendor managed inventory (VMI) method, which is policy all inventory planning is carried out by the producer company (PT. XYZ-Medan Mill). The customer receives input from the company manufacture. Robustness of information and trust integration is needed in this case. This policy is carried out as a basis for determining size optimum combined lot. As for integration with VMI in the company can be seen in the following figure 3.

![Figure 3. VMI Work Network Integration Model at PT. XYZ-Medan Mill](image)

4.2 Analysis of the Difference Between Request Amount and Total Available
Based on the results of data processing, the recapitulation of the difference results was found between the number of requests and the total available is as follows.

### Table 2. Difference Between Demand Amount, Amount of Production, and Inventory of Chicken Feed Products 105 ISA (Mash) PT. XYZ-Medan Mill

| Period   | Number of requests (Bags) | Total Request (Bags) | Rate Production (Bags) | Total Available (Bags) | Difference (Bags) |
|----------|---------------------------|----------------------|------------------------|------------------------|-------------------|
| SW (Bags)| BT (Bags)                 |                      |                        |                        |                   |
| Sept 17  | 21.355 9.426              | 31.500               | 34.000                 | 34.000                 | 3.219             |
| Oct 17   | 25.241 9.076              | 33.720               | 36.939                 | 36.939                 | 2.622             |
| Nov 17   | 23.628 11.662             | 31.320               | 33.942                 | 33.942                 | (1.348)           |
| Dec 17   | 21.175 11.166             | 36.000               | 34.652                 | 34.652                 | 2.311             |
| Jan 18   | 24.946 11.538             | 31.500               | 33.811                 | 33.811                 | (2.673)           |
| Feb 18   | 27.215 9.935              | 33.600               | 30.927                 | 30.927                 | (6.223)           |
| Mach 18  | 26.844 11.039             | 41.100               | 34.877                 | 34.877                 | (2.616)           |
| Apr 18   | 24.249 10.775             | 40.800               | 37.794                 | 37.794                 | 2.770             |
| May 18   | 26.185 10.788             | 42.000               | 44.770                 | 44.770                 | 2.770             |
| June 18  | 28.695 12.287             | 36.600               | 44.397                 | 44.397                 | 4.397             |
| July 18  | 30.324 11.513             | 36.300               | 39.715                 | 39.715                 | (2.032)           |
| Aug 18   | 27.469 10.602             | 38.071               | 36.848                 | 36.848                 | (1.223)           |

The table above shows that there are variations that cause product buildup (over stock) in the period September 2017, October 2017, December 2017, April 2018, May 2018, and June 2018 and product shortages (stock out) in the period November 2017, January 2018, February 2018, March 2018, July 2018 and August 2018. Based on the discussion of these problems, it is necessary to have a good plan in deciding how much should be provided by the manufacturing company to meet the demand. Planning department or commonly referred to as PPIC Department is needed to control optimal production and be able to meet consumer needs. The PPIC department must create a new strategy in solving problems that occur and one of the strategies that can be used in determining the number of lots is the application of the JELS method with the supply chain approach.

### 4.3 Analysis of Optimal Joint-Lot Size Iteration Calculation

Based on the results of data processing, recapitulation of iteration results from the optimal Joint-Lot size based on Total Cost is as follows:

### Table 3. Recapitulation of Iteration results TC

| Numb. | m | n | Q (Bags) | B (Bags) | QM (Bags) | TC (Rp) |
|-------|---|---|----------|----------|-----------|---------|
| 1.    | 1 | 1 | 95.866   | 548      | 96.414    | 1.650.985.790 |
| 2.    | 1 | 2 | 51.860   | 593      | 104.313   | 1.589.532.704 |
| 3.    | 1 | 180 | 2.420 | 2.488    | 438.088   | 5.130.179.586 |
| 4.    | 2 | 1   | 134.851  | 770      | 135.621   | 2.119.221.625 |
| 5.    | 2 | 2   | 71.536   | 817      | 143.889   | 1.990.271.781 |
| 6.    | 2 | 162 | 2.688   | 2.487    | 437.943   | 4.809.015.958 |
| 7.    | 3 | 1   | 164.846  | 942      | 165.788   | 2.493.391.892 |
| 8.    | 3 | 2   | 86.819   | 992      | 174.630   | 2.318.373.721 |
| 9.    | 3 | 149 | 2.917   | 2.482    | 437.115   | 4.693.487.338 |
| 10.   | 4 | 1   | 190.163  | 1.086    | 191.249   | 2.813.874.350 |
| 11.   | 4 | 2   | 99.779   | 1.140    | 200.698   | 2.601.882.279 |
The optimal lot size calculation aims to determine the size of the lot of the shipment of raw materials from suppliers to the company or the calculation of the optimum lot from the company to the buyer based on the most optimum total cost. Based on the calculation after iterating for the delivery frequency $m = 1$ to $m = 15$ according to Table 3 we found a solution with a minimum TC when $m = 13$ and $n = 50$ with Rp. 4,548,249,599. It can be seen in Table 3 that companies should order 13 times the raw material and ship the product 50 times to the buyer. One time ordering of raw materials and one delivery in one year is assessed because this feed product is a consumption product that has a proper period of consumption.

5. Conclusions

Based on the analysis of processing and discussion of data, several conclusions can be drawn, namely:

1. Based on the calculation of total cost using the Joint Economic Lot Sizing method, the optimum total cost is Rp. 4,548,249,599 with a shipping lot size to buyers of 8,692 bags, producing as many as $QM = 437,082$ bags and maximum product backorder, $B = 2,483$ bags and by scheduling the delivery of finished products to the buyer as much as 50 times with the frequency of ordering raw materials.
materials 13 times. When compared with existing conditions, the application of this method is better because it can save costs by Rp. 1,239,128,918.

2. Stock out and over stock often occur in companies which indicate that there is a deviation between production capacity and the number of consumer requests.

3. Sensitivity analysis shows that the cost of ordering raw materials and disposal costs are the costs that have the most significant influence on changes in total cost.

4. Factors causing the problem are the lack of integration and cooperation between suppliers, companies and buyers in determining lots. The PPIC department is responsible to the manufacturing company of the to coordinate and determine a plan in the production process is important to be formed immediately.

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