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Rindi Fitria Dewi
Master of Accounting Program, Faculty of Economics and Business, Universitas Indonesia
rindifitria@gmail.com

Eliza Fatima
Master of Accounting Program, Faculty of Economics and Business, Universitas Indonesia
elisa_fatima@yahoo.com

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Rindi Fitria Dewi*, Eliza Fatima
Master of Accounting Program, Faculty of Economics and Business, Universitas Indonesia

ABSTRACT

This study aims to analyze the inventory management in PT XYZ, a flour manufacture company and to propose improvement of production planning in order to maintain the work in process and finished goods inventory quantity in low level. This study use a case study method with qualitative approach. The data used are primary and secondary data, using instrument such as interview with staff and management of PT XYZ, as well as historical data of the company. The result of the study are suggestions to improve the inventory management by classifying inventory with always better control (ABC) analyst, using single moving average method to calculate sales forecast, revissing the calculation of overall equipment effectiveness (OEE), and improment the calculation of buffer inventory. The result of the research are not necessarily applicable to other companies with different demand patterns or to companies with different industries. In addition, the methods used to calculate sales forecast and buffer inventory are limited in this study.

Keywords: *ABC Analyst, Buffer Inventory, Inventory Management, Manufacture, Sales Forecast.*

* Corresponding Author's Email: rindifitria@gmail.com

1. INTRODUCTION

Business competition faced by companies is not only related to low product prices, but also related to the added value provided to customers and the speed of availability of goods (Bhushan et al., 2017). In order to survive in the market, manufacturing companies need to create competitive advantage, by creating products of the same quality at lower prices than competitors or by creating differentiated products (Thompson et al., 2018). Companies must also maximize customer satisfaction in order to continue to compete (Dalci, 2006).

The Just in Time (JIT) production system is a tool to make companies more competitive and has been used by many manufacturing companies. The JIT system uses a demand-pull approach, in which consumer demand for finished goods inventory becomes the trigger for each stage of the production process. Thus each component of production is made only if there is consumer demand. The application of JIT can reduce inventory storage costs, improve product quality, reduce production completion lag times, and reduce production costs by minimizing costs and activities that do not add value. With reduced inventory levels, costs and production lead times, the company's responsiveness to customer needs will increase. JIT production systems can help companies meet demand for high-quality products, at relatively lowest prices (Horngren et.al., 2018).

The challenge of implementing JIT is the high probability of sudden changes in production and sales planning, while the production period is in progress. This is often due to changes in consumer orders, such as changes in delivery dates, quantities and types of products ordered. Besides that, JIT can cause conflicts between functions, involving several related departments (Xu & Chen, 2016).

Some of the success factors for companies implementing JIT systems are the accuracy of projections to maintain raw material inventories at the right level (Pimpale, 2021). In addition, sufficient control is needed for semi-finished inventory (Bhushan et al., 2017) and for buffer stock so that it is always in minimum quantity (Bon and Garai, 2009).

Competition in the wheat flour manufacturing industry in Indonesia is quite tight, because the differentiation between products produced by producers is not much different. There are several big players that have been operating for a long time and already have existing captive markets, so they can dominate the market (Cerestar Prospectus, 2022).

PT XYZ is a flour manufacturing company resulting from a joint venture of three companies from Indonesia, Japan and Malaysia. This company was founded in 2012 and started operating in 2015. Currently PT XYZ has three factories located in the cities of Cilegon, Makassar and Medan. Besides producing wheat flour as the main product, PT XYZ also produces animal feed as a by-product. As of June 2022, PT XYZ's total products are 72 products, consisting of 57 flour products and 15 by-products. Comparison of sales of flour products dominates in the range of 80 to 85 percent of the company's sales. PT XYZ has experienced rapid growth in its 7 years of operation, due to the use of a flour blending system technique that is not owned by other manufacturers in the milling industry in Indonesia, which produces flour products with special specialties according to consumer wishes and enables the most optimal extraction of wheat grain. The company's rapid growth has brought PT XYZ to the second rank, the producer of wheat flour in Indonesia with the largest sales during 2020 and 2021 (Prospectus Cerestar, 2022). The majority of PT XYZ's consumers are food and beverage manufacturing companies. Thus PT XYZ has a competitive advantage in the form of creating differentiated products.

PT XYZ wishes that in the future it can adopt the production strategy of one of its parent companies, namely TYT from Japan. TYT has implemented a JIT system, in which the raw material and work in progress inventories will be used in the production process, only if orders from consumers have been received by the company. So that TYT keeps the amount of inventory at a minimum level and avoids excess inventory when it enters disposal time (Pimpale, 2021).

The target age limit for finished goods inventory storage at PT XYZ's factory warehouse before delivery to consumers or distributors is 3 weeks from the date of production. While PT XYZ's product quality standard is a maximum of 3 months from the date of production. If the product is stored in the factory warehouse with an age close to the maximum quality standard, it will be re-processed (reflour process).

Until now PT XYZ's production planning is carried out every week, namely on Thursday, for the next week's production period which starts from Monday to Sunday. The production planning is made based on weekly sales forecasts or projections, which are updated every Wednesday. Sales forecasts or projections are made based on data on product orders that have already been entered, information from consumers who are considered trusted partners, that will soon be sending product orders, as well as from the company's historical sales data.

However, PT XYZ often experiences production and inventory management problems caused by a sudden decline in sales from sales projections which results in excess inventory levels in the warehouse; sudden high demand for products resulting in an out of stock of inventory and causing a loss of sales opportunities (opportunity cost of sales); there is a new and urgent demand for products with special specifications which has an impact on delaying production schedules and delays in product delivery; as well as the uncertainty of the amount of by-product inventory due to sudden changes in the production planning of the main product. Until now, PT XYZ still often handles problems using a case-by-case approach.

This study uses a case study strategy with a qualitative approach, to evaluate problems within the company in order to present solutions (Ellet, 2009). The focus of this research is on the evaluation of inventory management at PT XYZ. This research ends with practical solutions or recommendations for inventory management at PT XYZ, in order to achieve low levels of semi-finished inventory and finished goods inventory. The study questions are how the implementation of inventory management at PT XYZ is; and how production planning is so that the level of semi-finished inventory and finished goods inventory can reach a low level.

2. LITERATURE REVIEW

2.1. INVENTORY MANAGEMENT

Inventories are divided into raw materials, work in progress, and finished goods (Waters, 2003). Inventory management is carried out to minimize the possibility of disruption to the production schedule by keeping inventory in sufficient quantities to produce maximum economic value (Waters, 2003). The focus of inventory management is the number of orders, order intervals, and inventory control systems (Zomerdijk & Vries, 2003). The amount of inventory is kept in balance, because if the amount is excessive it will increase storage costs (Gimenez & Ventura, 2005). Determining the right level of inventory for a company is one of the big management challenges (Radasanu, 2016).

ABC analysis (always, better, control) is an inventory classification method based on the Pareto principle, where 80% of the inventory value is obtained from 20% of the types of inventory owned by a company. According to Heizer (2014), inventory is classified based on use value or investment value from the highest to the lowest in 3 categories. Category A is inventory with a usable value of up to 70%-80% of the usable value of inventories and consists of 10%-20% of the types of inventory held, which requires the strongest control and high accuracy. Category B is inventory with a usable value of between 15%-20% of the total inventory value and consists of 30% types of inventory, which requires medium control and accuracy. Category C is the inventory with the lowest useful value of 5% and conversely has the most types of inventory reaching 50% of the types of inventory owned by the company, which requires low control and accuracy.

Demand planning is used as a basis for preparing production planning, raw material requirement planning and delivery planning. The selection of demand forecasting methods must consider the conditions and needs of the company, such as the time span or demand forecasting period, the availability and relevance of historical data, the types of products offered by the company, the accuracy of forecasting, and the basis for calculating the quantity of customer demand (Armstrong, 2006). There are several methods for making sales forecasts (Lehaney, Mason, & Lind, 2017).

The simple moving average (SMA) method, is making sales projections by calculating the average value of historical data in a certain range to serve as a forecast value for the next period (Lehaney, Mason, & Lind, 2017). This method is calculated by the following equation.

$$\mathrm{SMA} = \frac{(\mathrm{A_n} + \cdots + \mathrm{A_2} + \mathrm{A_1})}{\mathrm{n}}$$

with A_n, data of the previous n periods; A_2, data from the previous 2 periods; A_1, data from 1 previous period; and n stands for number of periods.

The weighted moving average (WMA) method is a development of the simple moving average method with the addition of distributed weights. The weight on the previous data is smaller than the weight on the latest data, so that the latest data has a greater impact on the forecast calculation results (Lehaney, Mason, & Lind, 2017). The total weight value is 1. This method is extending above method and calculated by the following equation:

$$WMA = A_n \text{ x } W_n + \cdots + A_2 \text{ x } W_2 + A_1 \text{ x } W_1$$

with W_n, weighted for data of the previous n periods; W_2, weighted for data from the previous 2 periods; and W_1, weighted for data from 1 previous period.

The exponential moving average (EMA) method is a forecast calculation that is also developed from the simple moving average method, where the calculation uses exponential weights (Lehaney, Mason, & Lind, 2017). So that the weight values used are more sensitive to the momentum of recent changes in the latest data, compared to past data. This method is calculated by the following equation:

$$EMA = \left((C - P) \text{ x } \frac{2}{(n + 1)} \right) + P$$

with C, data from 1 previous period; P, data resulted from simple moving average in 1 previous period; and n stands for the number of periods.

Forecast value accuracy can be done by comparing the mean squared error (MSE) value, which is the average squared error value between the actual data and forecast data made and aims to provide an estimate of the size of the error in the forecast. The smaller the MSE value indicates that the error is smaller and the forecast results are closer to the actual data (Lehaney, Mason, & Lind, 2017). The MSE value can be obtained through the following equation:

$$MSE = \frac{\sum_{t=1}^{n} (At - Ft)^2}{n}$$

with At; actual data; Ft, forecasted data, and n stands for the number of periods.

Barriers to newly established manufacturing companies are inefficient production and sales planning (Akande, 2019). This is often caused by weak internal controls, no segregation of duties, and authorization matrices that are not based on best practice. Production and sales planning needs to be accompanied by adequate inventory management, so as not to disrupt the production process and be able to meet customer demands (Kumar & Suresh, 2008). Operations management in manufacturing companies must maximize company resources (Fajar & Lestari, 2017). Operations management that does not maximize the resources it has will harm the company, such as increased costs, ineffective business processes, and inventory shortages. Production planning as one of operations management must utilize resources effectively and efficiently in production activities. Production planning aims to gain profits and control the target market, and as a basis for measuring the performance and productivity levels of a company. The production planning process needs to pay attention to production capacity so that it can be realized effectively (Bonney, 2000).

Overall Equipment Effectiveness (OEE) is a tool for measuring the operational or production effectiveness of a manufacturing company (Stamatis, 2010). OEE consists of components of availability, performance, and quality, where the calculation is as follows:

$$\text{OEE} = availability \text{ x } performance \text{ x } quality$$

The availability component measures the level of effectiveness of operating hours or machine work in operation, which may not reach 100% if there is a disturbance that reduces machine working hours. The availability equation is as follows:

$$Availability = \frac{\text{Working hour machine} - downtime}{\text{Working hour machine}}$$

The performance component shows the level of effectiveness of the engine speed by comparing the actual engine speed to the ideal engine speed. Actual machine speed may be lower than ideal due to slow operator performance and operator error in operating the machine. Performance value can be calculated through the following equation:

$$Performance = \frac{\text{Total unit produced}}{(\text{Working hour machine} - downtime) \text{ x } cycle\ time}$$

The quality component describes the level of machine effectiveness in producing defective products, using the following calculations:

$$Quality = \frac{\text{Total unit of good products}}{\text{Total unit produced}}$$

Safety stock is a buffer stock that is stored to deal with unpredictable market demand in the short term, uncertain lead times and availability of raw materials from suppliers (King, 2011). Safety stock aims to avoid stock out costs, namely costs incurred due to the absence of inventory to meet customer demand. If stockout costs are low, companies can eliminate safety stock, thereby lowering holding costs. However, if stockout costs are at a moderate level, then the company needs safety stock, because it can reduce the possibility of stock outs. Companies can balance the storage costs incurred by safety stock by making low safety stock (Horngren et.al., 2018). There are several equations for calculating safety stock (King, 2011), one of which is as follows:

$$\text{Safety Stock} = \text{Z x} \sqrt{\left(\frac{\text{PC}}{\text{T}_1} \text{ x } \sigma_\text{D}^2\right) + (\sigma_{\text{LT}} \text{ x } \text{D}_{\text{avg}})^2}$$

with z, z-score of service level; PC, production cycle; T_1, time increment to calculate standard deviation of demand; σ_D, standard deviation of demand; σ_{LT}, standard deviation of lead time; and D_{avg}, average demand.

Goncalves et al. (2020) in their research regarding models and methods for determining buffer stock, revealed that the equation for calculating the safety stock above can be used when there is uncertainty in demand and variations in lead time. Schmidt et al. (2012) in their research related to calculating the appropriate buffer supply level to meet service level demand and produce low inventory levels, revealed that the above equation can produce low buffer supply levels and reach the target service level, if demand has high variations.

2.2. PRIOR STUDY

Research related to production planning and inventory control in mattress manufacturing companies conducted by Myra Soeltanong (2021), found that inventory problems can arise because the company's system is still conservative and family-friendly, so the company does not move dynamically. As a result, the production planning and inventory control systems applied to companies are subjective, without being based on precise calculations (Myra, 2021). The recommended research recommendation is the establishment of an inventory control system using the Economic Order Quantity (EOQ) method, safety stock, and reorder points.

Dania Yapono (2021) in her research related to inventory management in the ornamental plant business, revealed that inventory control that has not implemented logistical control functions, can be improved by using ABC analysis to prioritize handling of ornamental plants. Besides that, Dania Yapono (2021) recommends inventory management using the moving average, stock keeping unit, safety stock and reorder point methods.

Ferry Harmen (2017) in his research related to the management and improvement of inventory control procedures at the Tax Court Secretariat, proposed improving weak inventory control in research objects by using buffer stock and reorder point calculations. Besides that, Ferry Harmen (2017) recommends improving admission procedures; storage and maintenance; distribution; and inventory records.

The difference between this research and previous research besides the type of business the object of research is the sales forecast selection stage. In this study, this stage begins with calculating the forecast value using 3 forecast calculation methods, namely the Single Moving Average (SMA), Weighted Moving Average (WMA), and Exponential Moving Average (EMA). Next, the calculation of the Mean Squared Error (MSE) value of each method is performed, then 1 method is selected that has the lowest Mean Squared Error (MSE) value to be used as the proposed method for calculating sales forecasts. Whereas in Myra Soeltanong's research (2021), the customer demand forecasting method has been determined at the beginning, namely the Single Moving Average (SMA) method.

The next difference is in the equation used to calculate the buffer stock. In this study, buffer supply is calculated using an equation that requires the value of service level, production cycle, time increment in calculating the standard deviation of demand, standard deviation of demand, standard deviation of lead time, and average demand. Whereas in Ferry Harmen's research (2017), the equation for calculating buffer supplies only requires service level values and standard deviation of demand. This happens because the research data has a high variation in the quantity of supply requests, whereas in Ferry Harmen's research (2017) the variation in the quantity of supply requests is relatively low.

3. RESEARCH METHODS

The method used in this research is a case study at PT XYZ. The approach taken for research is qualitative with a deduction model. The deduction model is a research tool by logically drawing conclusions using valid premises to find problems, build hypotheses, conduct field observations to test data (Bungin, 2007). Thus, the results of this study can provide solutions and recommendations for improving inventory management, in order to provide low levels of semi-finished inventory and finished goods inventory at PT XYZ.

This study uses primary data and secondary data. Primary data was obtained from interviews with upper management, as well as those involved in the inventory management process at PT XYZ. While secondary data consist of sales, production, warehouse, and finance report.

The interviews conducted in this study were semi-structured interviews, which allowed researchers to explore the problem in more depth and aim to gain a broader perspective from the informants. In this semi-structured interview, the author has prepared structured questions to serve as a guide for additional questions in the interview process (Bastian Winardi & Fatmawati, 2018). The study held by conducted observations at PT XYZ and interviews with 5 groups of relevant informants since May 2022, with the aim of understanding the problems faced and the root causes of the case study evaluating inventory management at PT XYZ. The five groups of informants are Production and Warehouse Team, Sales Team, General Manager of factory, Top Management, and Internal Audit Team.

This study used a qualitative descriptive analysis to describe the data and information obtained through interviews and company documents. The research begins with the process of analyzing the results of the interviews and the process of interpreting company documents related to inventory management which have been mentioned in the previous sub-chapter. Furthermore, the process of confirmation and validation of the suitability of the interview results with company documents is carried out. If this study found no differences between the documents and the results of the interviews, then proceed with a comparison of the two with the relevant theoretical literature. It aims to obtain a comprehensive analysis of the implementation of inventory management at PT XYZ, and an analysis of the root causes related to the ineffectiveness of inventory management. The analysis leads to recommendations for improving inventory management in order to achieve low levels of semi-finished and finished goods inventory at PT XYZ.

4. ORGANIZATION PROFILE

PT XYZ is a flour manufacturing company resulting from a partnership of three companies from Indonesia, Malaysia and Japan. This company was founded in 2012 and started operating in 2015. Currently PT XYZ has three factories located in the cities of Cilegon, Makassar and Medan. Wheat raw materials used come from Australia, India, Eastern Europe, the United States and Canada. Until June 2022, PT XYZ's market is 95 percent of the domestic market and 5 percent of exports to Singapore, China and the Philippines. The majority of PT XYZ's consumers are food and beverage manufacturing companies. PT XYZ has a goal to become the leading flour producer in Indonesia.

PT XYZ experienced rapid growth within 7 years of operation. In 2019, PT XYZ was ranked fifth as the producer of wheat flour with the largest sales in Indonesia (Cerestar Prospectus, 2022). Then in 2020 and 2021, PT XYZ won the second rank consecutively. PT XYZ uses a flour blending system technique that is not owned by other producers in the milling industry in Indonesia. This technique accelerates the availability of finished goods, especially finished goods with specifications according to consumer demand. This technique also produces the most optimal wheat grain extraction. Thus PT XYZ has a competitive advantage in the form of creating differentiated products.

PT XYZ's largest factory, located in Cilegon City, has a production capacity of 2,000 metric tons per day and a storage capacity of 140,000 metric tons of wheat raw materials. Besides producing flour as the main product, PT XYZ also produces animal feed as a by-product. As of June 2022, PT XYZ's total products are 72 products, consisting of 57 flour products and 15 by-products. Where the comparison of sales of flour products dominates in the range of 80 to 85 percent of company sales.

PT XYZ has finished goods inventory stored in the factory warehouse with a maximum shelf life of 3 weeks from the date of production. If the finished goods inventory is not sold and is not sent out of the warehouse, up to the maximum storage limit in the warehouse, then the finished goods inventory will be reprocessed (refloured) to become another product that meets company standards.

Intense competition in the flour industry in Indonesia and the maximum shelf life of finished goods in warehouses is relatively short, pushing PT XYZ to improve inventory management. PT XYZ often experiences inventory management problems, including excess or shortage of finished goods inventory, there is an urgent demand for products with special specifications which results in delays in production schedules and delays in product delivery, as well as uncertainty in the amount of by-product inventory due to sudden changes in the main product production plan. Until now, PT XYZ has often handled problems using a case-by-case approach.

PT XYZ's inventories consist of raw material, work in progress and finished goods. Appendix 1 presents a summary of PT XYZ's inventories. There are 72 types of products offered by PT XYZ, consisting of 48 flour names or brands, 9 of which have 2 size options and 15 animal feed brands. Inventories of finished goods in the form of flour products, have major differences in protein content, degree of granulation and charcoal. While the supply of finished goods in the form of animal feed products, differentiated based on the content of the skin (bran) and eye (germ) of wheat.

Work in progress inventory consist of two types, namely basic flour, which is obtained from the milling of wheat raw materials, and unpackaged flour, which is the result of the process of mixing basic flour with other additional raw materials. There are 8 types of basic flour, namely CWRS, F2CWRS, AH, ASW, SWW, RUS, UKR, and ARG. While the supply of unpackaged raw materials totaled 63 types, consisting of 48 brands of flour and 15 brands of animal feed. Raw material inventory is excluded from the research scope.

Inventory management at PT XYZ is coordinated by the PPIC Department which is responsible for the production planning process, planning for purchasing materials other than wheat raw materials, and monitoring the levels of raw material, work in progress and finished goods inventory. The PPIC Department coordinates with parties directly related to inventory management, namely the Sales Division, Production Division, Warehouse Department, Purchasing Department, Grist Committee, Printing and Packaging Storage Department, QA/QC Department, Research and Development Department and Finance Department. PT XYZ has several policies and procedures related to inventory management which are the basis for operational activities and as ISO standard requirements.

5. RESULT AND DISCUSSION

5.1 IMPLEMENTATION OF INVENTORY MANAGEMENT IN PT XYZ

5.1.1 SALES PLANNING

The Sales Department prepares a sales plan that is used as a reference for PT XYZ's inventory management. PT XYZ's sales planning consists of two types, namely the monthly rolling forecast and the weekly sales forecast. PT XYZ's monthly rolling forecast contains sales forecast for the next six month period using actual sales accumulation data. PT XYZ's rolling forecast is updated on the 20th of every month. The monthly rolling forecast is used as the basis for purchasing raw material inventories, namely wheat, where the safety stock policy is sufficient for the production process for the next three months. The accuracy of the monthly rolling forecast has a direct impact on the availability of PT XYZ's raw material inventory, as lead times for purchases reach two to three months. So that if there is a significant difference between the rolling forecast and the actual sales forecast, it can cause an excess or shortage of wheat safety stock. If there is a shortage, PT XYZ will buy wheat from other nearby flour producers or buy wheat from the nearest country, namely from Australia. Conversely, if there is an excess of wheat, PT XYZ can sell wheat to other flour producers, store excess wheat inventories in the nearest affiliated company factory silos, and adjust wheat purchases for future periods.

Weekly sales forecasts are prepared based on rolling forecasts and sales orders that have been received. Weekly sales forecasts are compiled every Wednesday and are used as the basis for PT XYZ's production planning. Sales orders consist of regular orders and insert orders. Regular orders are sales orders that have been calculated in the sales forecast and production schedule, while insert orders are sales orders that are not calculated in the sales forecast and production schedule, so that if accepted it will cause changes to the production schedule.

PT XYZ's business analyst, who is responsible for compiling monthly rolling forecasts and weekly sales forecasts, stated in interviews that there are characteristic differences in sales forecasts for each customer group. PT XYZ has three customer groups, namely general trade, industry and exports. Sales orders from general trade group customers tend to be unpredictable, because the products ordered are general and fast moving, where the product quantity for each sales order tends to be smaller than other customer groups. Often general trade group customers send sales orders 1 day before the product delivery date. So that in making weekly sales forecasts for these customer groups, most of the data is forecast results and only a small part is based on sales order data that has been received.

Sales orders from industry group customers tend to have a longer time span from the date the sales order is received to the product delivery date. Products ordered from industrial groups vary from general products that are fast moving, special products (made by order) that can be sold to more than 1 customer, to special products that can only be sold to 1 customer. In addition, the product quantity for each sales order is relatively larger than the general trade customer group. So that the accuracy of the sales forecast for this customer group is relatively higher than the general trade customer group. Meanwhile, sales orders from customers in the export group have a better order flow, because sales forecast data for this group are only made based on sales orders that have been received. So that the sales forecast for this group becomes accurate. The products ordered from the export customer group are the same as the products for the industrial customer group.

PT XYZ classifies its finished goods inventory based on the level of inventory turnover, which consists of fast moving, medium moving, and slow moving inventory groups. The grouping is carried out subjectively by the PPIC and Sales Departments without using a standard measurement basis. This grouping is used by PT XYZ to make decisions regarding buffer supplies.

Furthermore, to achieve research objectives, help determine inventory handling priorities at PT XYZ and make references in preparing PT XYZ inventory management improvement policies, this research conducts inventory counts using Always Better Control (ABC) analysis. The result of the ABC analysis is the grouping of all types of inventory of PT XYZ into category A, B, and C. The calculation of the ABC analysis uses the useful value of the inventory, which is obtained by multiplying the amount of inventory sold in the period January to June 2022, with the average cost of goods sold from each inventory. The results of the ABC analysis of PT XYZ Inventory is presented in Appendix 2.

The ABC analysis can be the basis for PT XYZ in carrying out inventory control. Category A inventories consist of 13 types of inventories, which are equivalent to 18.31% of the total inventories, giving PT XYZ the useful value of the inventories or cost of sales of up to 80%. Thus inventory in category A must be subjected to the most stringent control, more accurate recording and more frequent supervision. Furthermore, category B inventories consist of 19 inventories, equivalent to 26.76%, giving the usable value of the inventories or cost of goods sold up to 14.97%. Thus, supplies in this category require second attention after category A. Inventories in category C consist of 39 inventories, equivalent to 55% providing the smallest usable value of inventories, namely 4.49%, so that inventories in this category require minimal control.

The policies that can be implemented based on the ABC analysis include: control by using a buffer inventory for all supplies in category A is necessary, so that there is sufficient inventory in the category with the largest sales quantity. Besides that, it is necessary to calculate the correct forecast so that there is no excess production and an excess of the maximum amount of inventory in the warehouse, which causes large carrying costs. Adequacy of category A buffer inventory can also keep PT XYZ from losing opportunities to sell due to lack of inventory. Control using buffer inventory is necessary so that inventory in category B, which has more than 1 customer and requests occur continuously every 3 weeks, can have low inventory levels in the warehouse. Making buffer inventory is excluded for inventory in category B which only has 1 customer and there is no continuous demand every 3 weeks. Control that can be carried out for category C is not to create a buffer inventory for products that are made by order, where these products only have 1 customer. Whereas for inventory in category C which has more than 1 customer and there is continuous demand every 3 weeks (maximum limit for inventory storage in the warehouse) a buffer inventory can be made with a smaller amount than inventory in category A and B.

PT XYZ's business analyst stated in an interview, that there are problems related to sales planning, namely there is often a significant difference between weekly sales forecasts and actual weekly sales. In the first and second weeks of each month, actual sales are often significantly lower than forecasts. In the fourth week, on the other hand, actual sales are often significantly higher than forecast. This was caused by several factors, including changes in market demand; cancellation or delay of sales from customers; and price competition with competitors. In animal feed products, several factors causing the difference in forecasts with sales are the insufficient supply of work in progress to make animal feed by-products, because they adjust to the production of the main flour product, so that customers switch to other substitute animal feed products offered by PT XYZ. Another contributing factor is customer cancellations due to changes in customer needs to adjust the growth cycle of their livestock.

Furthermore, to evaluate the sales forecast and determine the accuracy of the sales forecast for each PT XYZ product, this study calculates the difference between the weekly sales forecast and the actual weekly sales, then calculates the number of weeks the actual sales occur according to the forecast; number of weeks with no actual sales but forecasted sales; the number of weeks in which actual sales were not forecast; and the number of weeks in which actual sales were higher and lower than forecast. This study validates the problems related to actual sales in the first and second weeks of each month which are often lower than the third and fourth weeks, which is known from the results of interviews with PT XYZ's business analyst above. Validation is done by calculating the number of weeks when actual sales are higher or lower than forecast, which are divided into 8 percentage ranges. The results of these calculations are presented in Appendix 3. The data analyzed in this study are actual and forecast sales data for PT XYZ that have not been processed, from January to June 2022, with a total of 25 weeks for 72 products. The inventories presented in Appendix 1 are sorted based on the order of the names of the inventory results from the ABC analysis. It is intended that Appendix 3 can present the differences in actual sales of products that provide the greatest to the smallest utility value.

Inventory in Appendix 3 with sequence numbers 1 to 19 is category A, has a total value that frequently appears is 25 weeks, so inventory sales in this category occur every week. However, inventories within the order number range have high fluctuations in the realization of sales forecasts, this can be seen from the large number of weeks that have higher or lower actual sales than forecasts. Inventories numbered 20 to 32 are category B, having a total value of between 11 and 25 weeks, so inventory in this category also experiences sales between every 1 to 2 weeks. However, the fluctuation in the realization of the sales forecast in this category was not as high as in category A, this was evident from the decrease in the frequency of the number of weeks that had actual sales higher or lower than forecast. Then inventories of order 33 to 72 are category C, having the lowest fluctuations in the realization of sales forecasts, this can be seen from the lowest frequency of the number of weeks that actual sales are higher or lower than forecasts. However, inventory sales in category

C often occur without a forecasting process, where orders are received during the production week, so these orders are insert orders.

However, there are 2 products IKWI-50 (number 5) and IKWICHN-50 (number 37) for which sales forecasts are not made even though they always have sales every week. Based on an interview with PT XYZ's By-Product Sales Manager, the exception for the two supplies is PT XYZ's management policy, because it relates to IKWI-50 and IKWICHN-50 products, which are animal feed by-products with a number of ingredients raw materials that have the least amount and have the lowest economic value, namely derived from the skin and wheat heads. So that KWI products are automatically produced with or without sales forecasts.

Another problem that arises related to the sales process is the accuracy of the delivery schedule with the actual delivery date. The delivery schedule is contained in the sales order document and work order (SPK) which are made based on purchase order data received from the customer. SPK documents that contain delivery schedules often experience differences compared to the actual delivery schedule. This study calculates the difference between the actual delivery date and the delivery schedule at SPK for sales orders from industrial and general trade customer groups in the period January to June 2022. The results of the research calculations are presented in Appendix 4. Based on the explanation from the Sales Department in the interview, the cause of the difference in the delivery date being earlier or later than the schedule was due to an error in the estimated travel time to the PT XYZ factory, both for loco and franco shipments. In loco-type shipments, shipping costs are charged to the customer, so that the coordination with the transporter is carried out by the customer. Whereas for loco type shipments, the shipping costs are borne by PT XYZ, thus coordination with the transporters is carried out by PT XYZ. In the industrial category, delivery occurred ahead of schedule for 1,133 sales orders, which is equivalent to 31.67% of total sales orders from customers in the industrial category. The Sales Department explained in an interview that the difference was due to requests from customers to speed up delivery, due to changes in the raw material needs of customers' production which became faster.

For problems related to the sales process, PT XYZ's weekly sales forecast calculations were performed using 3 sales forecast calculation methods, then 1 method was selected which had the lowest Mean Squared Error (MSE) value. The MSE value was chosen in this study as an indicator of the accuracy of the sales forecast, because PT XYZ's weekly sales forecast has a zero value or no forecast for a particular week. The sales forecast calculation method used consists of 3 methods, namely Single Moving Average (SMA), Weighted Moving Average (WMA), and Exponential Moving Average (EMA). The calculation and selection of PT XYZ's weekly sales forecast method can be seen in the Appendix 5.

The results of the comparison of MSE values are presented in Figure 4, where the method that produces the lowest MSE values for each product is the SMA method which occurs in 32 products. Thus the SMA method can be proposed to PT XYZ to calculate sales forecasting. The results of calculating sales forecasts using the SMA method along with actual sales data are presented in Appendix 7.

5.1.2 PRODUCTION PLANNING

The PPIC and Sales Departments hold weekly production planning meetings every Thursday, for the following week's production period starting from Monday to Sunday. In planning production, the PPIC Department uses weekly sales forecasting data as a basis for planning inventory of raw materials other than wheat and planning production targets.

The production target plan consists of a weekly production schedule and a weekly sack packaging printing plan. In preparing the production schedule, the PPIC Department considers production capacity; inventory estimates at the beginning and end of the production week; inventory of incoming and outgoing finished goods; as well as dispositions or special requests from the Quality Assurance Department. Incoming finished goods inventory consists of production results, repackaging results, and returns from customers. While finished goods inventory that comes out consists of sales shipments, failed products, sample products, and reprocessing products. The daily production schedule consists of three shifts. The first shift is from 12pm to 8am, the second shift is from 8am to 4pm, and the third shift is from 4pm to 12pm. The flour and animal feed production process at PT XYZ is divided into three stages, namely the milling, mixing, and packaging processes.

Based on the results of interviews with the Assistant Manager of the PPIC Department, it is known that in preparing production planning apart from considering data related to sales and the availability of raw materials and other materials, the PPIC Department considers warehouse capacity, minimum buffer stock, aging time conditions, and the need for the fumigation process. Buffer supplies are mostly applied to fast moving products with a maximum amount to meet the needs of product delivery 3 to 5 days. The aging time condition is the time needed for flour quality to be maximized before the product is sent to the customer, which ranges from 7 to 8 days. Products that require aging time are flour with high protein content for the production of bread and noodles. While the need for the fumigation process depends on customer demand, which ranges from 5 to 13 days.

Based on the results of interviews with the Assistant Manager of the PPIC Department and the Production Manager of PT XYZ, it is known that the production schedule often changes during the production week. This is caused by several factors, namely changes in actual weekly sales compared to sales forecasts; inadequate raw material or work in progress inventory; technical problems in the production line; inventory of work in progress that do not meet quality standards; changes in product formulas from the Griss Committee; entry of insert customer orders (insert orders); sudden changes in sales requests; and directors' instructions. The PPIC Department makes adjustments to the production schedule if changes occur from Monday to Friday, thus there are no changes to the production schedule on Saturday and Sunday. If there is a customer order for inserts, the PPIC Department decides whether to accept or reject the order by considering several things, namely the availability of semi-finished supplies (basic flour); whether or not there is a request for fumigation process; checking the aging process of inventory of finished goods in the warehouse; packaging lead times; and the possibility to switch the production schedule of one product to another.

Furthermore, to evaluate the production schedule and find out the frequency of changes to the initial production schedule, namely the production schedule before revisions occur due to factors disclosed by the Assistant Manager of the PPIC Department and Production Manager of PT XYZ in interviews. This research calculates the difference between the initial production schedule and the actual production results for each PT XYZ product, the results of which are presented in Appendix 8. The calculation used is the same with the calculation for Appendix 3, which presents the difference between weekly sales and actual weekly sales. So the calculation related to the difference between the initial production schedule and the actual production results for each PT XYZ product in Appendix 8, aims to validate the impact of the difference between weekly sales and actual weekly sales presented in Appendix 3, on changes to the initial production schedule.

The research calculation in Appendix 8 uses data on actual weekly production results and PT XYZ's initial production schedule for the period January to June 2022, with a total of 25 weeks for 72 products. Comparison of forecasted weekly sales data with actual sales, sorted according to the order of inventory names according to the ABC analysis. Data from Appendix 8 has conditions similar to Appendix 3, the result of a comparison of weekly sales between actual and forecast, because changes in the realization of the production plan are the impact of changes in the realization of the sales forecast.

Product sequence number 1 to 19 is category A, has a total value of weeks that often appear is 25 weeks, so inventory in this category is produced every week, with high fluctuations in the realization of the initial production schedule, this can be seen from the large number of weeks that have actual production higher or lower than the initial production schedule. Supplies of sequence number 20 to 32 are category B, having a total value of between 11 and 25 weeks, so supplies in this category are also produced almost every week, but fluctuations in the realization of the initial production schedule are not as high as category A, this can be seen from the decreased frequency of the number of weeks that have higher or lower actual production than the initial production schedule. Then inventory sequence 33 to 72 is category C, has the lowest fluctuation in the realization of the initial production schedule, this can be seen from the lowest frequency of the number of weeks that have higher or lower actual production than the initial production schedule. However, inventory production in category C often occurs without the process of making an initial production schedule, where orders are received during the production week, so these orders are insert orders.

Based on the results of interviews with the Assistant Manager of the PPIC Department, sometimes PT XYZ can produce finished goods inventory that is an insert order, before the purchase order is received by the Sales Admin. This can be done if there is certainty of orders and delivery date information, and when the production schedule still allows the addition of new schedules.

Based on these production-related problems, an evaluation of PT XYZ's Overall Equipment Effectiveness (OEE) calculations can be carried out to see the effectiveness of the machines used in the production process. The OEE calculation in this study uses OEE data that has been calculated by PT XYZ for the availability and performance components. However, for the OEE quality data component that has been calculated by PT XYZ, a re-calculation is carried out in this study. This is based on the results of an interview with the assistant manager in the warehouse section, who revealed that the OEE compiled by PT XYZ does not count products that are not fit for sale, so if there is repackaging due to problems in the packaging process it is not counted as a factor that reduces the value of quality, because the amount Products requiring repackaging are viewed as small compared to the total units produced. In addition, the cost of using new packaging is considered low, which is an average of Rp. 300 per package and the rework time is less than 3 minutes per package.

OEE in this study used data from one of PT XYZ's flour production machine lines, namely the FP 1 Production Line, in the period from January to June 2022. PT XYZ has 8 production lines consisting of 6 flour production lines and 2 animal feed production lines. The results of PT XYZ's OEE calculations are presented in Appendix 9, which shows that the level of effectiveness of the FP 1 Production Line machines is in the range of 94.6% to 96.1%. PT XYZ's OEE value is used in preparing the production schedule, so that the production schedule is made according to the condition of the machine, so that the expected production results can be obtained.

The calculation of the availability value of the FP 1 Production Line is carried out by calculating the percentage value of the total planned machine working hours that have been deducted by the total disruption hours, to the total planned machine working hours. Total planned machine working hours, obtained from total operational working hours minus operational working hours without production activities, namely the time required for routine maintenance activities, waiting time for cleaning and replacing material in the machine bin, and hours without a production schedule. Total operational working hours is the total days in one month minus holidays, then multiplied by working hours per day, which is 24 hours, which consists of 3 shifts with a duration of 8 working hours per shift. The availability value of the FP 1 Production Line is in the range of 99.1% to 100% during the period January to June 2022, this indicates that the disruption that stops production activities is 0.9% to 0% of the total machine working hours, caused by damage to carrousel, packer, and seler, as well as power outages.

Calculation of the performance value is obtained by making a percentage value of the ideal production speed per package which has been multiplied by the total production units, then divided by the actual total working hours of the machine. The ideal production speed per pack is 0.1333 minutes, which is obtained from the standard machine specifications, which is 7.5 packs per minute. So that the performance value of the FP 1 Production Line is obtained which is in the range of 94.6% to 96.7% during the period January to June 2022. This shows that there is a slowdown in engine speed between 5.4% to 3.3% of the total speed ideal machine FP Production Line 1.

The quality value is obtained from the percentage of total production units that have been reduced by the total production units that are not fit for sale, then divided by the total production units. The quality value during January to June 2022 in this study was between 99.99% to 100%, this indicates that the amount of inventory that does not meet quality standards and requires reprocessing is 0.01% of the total units produced, due to scratches on the packaging due to constraints on the product packaging conveyor. The OEE value in this study is different from the OEE value compiled by PT XYZ, because the quality value compiled by PT XYZ is 100% consecutively from January to June 2022, because it does not count the number of product rework due to packaging damage, as the total products that are not fit for sale.

Furthermore, it can be proposed to make a buffer inventory calculation, the results of which are presented in Appendix 10. Inventories are sorted by product order in the ABC analysis, so that products are sorted by inventory use value from largest to smallest. The results of these calculations indicate that the greater the utility value of the inventory, the relatively large buffer inventory is needed. The steps of PT XYZ buffer inventory calculation can be seen in the Appendix 11.

5.1.3 RAW MATERIALS AND RESOURCES PLANNING

The results of material planning become the basis for making purchase requests for materials other than wheat by the PPIC Department, which will be processed by the Purchasing Department into purchase orders for suppliers. The received material is then stored in the raw material warehouse. Material planning in the form of wheat raw materials is carried out by the Commercial Director. Wheat raw materials are sent in containers, when the shipment process reaches the port, a fumigation process is carried out to control contamination by ticks and other insects. Furthermore, wheat raw materials are stored in PT XYZ's factory silos. Meanwhile, the weekly production schedule and product delivery schedule to customers are used as the basis for preparing the daily outsourced workforce requirements carried out by the Production Department.

The availability of PT XYZ's raw materials is rarely disrupted, causing a shortage or excess of raw material inventory. Constraints on the availability of raw materials that occurred were caused by external factors such as the supply of wheat raw materials from the State of Ukraine stopped due to the war so that replacements were sought from the State of Australia, which had an impact on the adjustment of the production process due to differences in the characteristics of wheat. Another obstacle is wheat shipments which were hampered at the start of the COVID-19 pandemic. On the other hand, the human resource needs for daily outsourced workers often experience changes, due to changes in delivery schedules and conditions of excess warehouse capacity. This causes an increase in production costs for the process of transporting and transferring products to delivery vehicles.

5.1.4 PRODUCTION PROCESS

The production process starts from manufacturing orders in the enterprise resources planning system by the PPIC Department which are sent to the production Department. Manufacturing orders are created based on production schedules and lists of raw materials, required for each process (grinding, blending, and packaging) and each type of inventory (raw material, work in progress, and finished goods) for one week.

PT XYZ's flour and animal feed production process is divided into three stages. First, milling is the process of changing the supply of raw materials, namely wheat into work in progress, namely basic flour. The milling process includes conditioning, cracking and refining steps that take 4 to 8 hours. The results of the milling process are stored in the basic flour production bin. Basic flour consists of the endosperm, bran, and germ. The endosperm is used for flour products and animal feed, while the bran and germ are used for animal feed products. The effectiveness of PT XYZ's milling process was assessed from the lead time of the process, the percentage of extraction of the endosperm part, and the achievement of the micrometer size of flour dust according to standards.

Second, mixing is the process of mixing several work in progress supplies, namely basic flour with additional ingredients to become unpackaged flour. The mixing process produces flour with certain specifications in a relatively short time, less than 2 hours. The results of the mixing process are stored in the unpackaged flour production bin. The effectiveness of PT XYZ's mixing process is assessed from the achievement of flour specifications with targets or quality standards. The mixing stage at PT XYZ uses a flour blending system technique which is not owned by other producers in the milling industry in Indonesia. This technique allows PT XYZ to produce several types of unpackaged flour with a relatively short lead time. Other flour manufacturers perform the mixing stage of the wheat prior to the milling stage for each product, requiring longer lead times. Third, packaging is the final process for packaging products based on the size and type of packaging, the result of the packaging process is in the form of ready-to-eat packaged flour stored in the warehouse. Flour products and animal feed have individual packaging areas that are more than 30 meters apart. PT XYZ's factory in Cilegon City has 4 production lines for flour products and 2 production lines for animal feed products. The packaging process takes less than 30 seconds per pack. The effectiveness of PT XYZ's packaging process is assessed from the process lead time.

Based on the results of interviews with the PPIC Manager, there are two things that are monitored every day by the PPIC Department related to the production process, namely the level of inventory of work in progress in the form of basic flour which is maintained so that it is not empty, and the condition of production support components, such as the lead time for cleaning the production bin which is may be needed at any time. The condition of the production supporting components influences the achievement of production lead time targets.

5.1.5 INVENTORY STORAGE PROCESS

PT XYZ's finished goods inventory is stored in 2 warehouse areas, namely the flour product warehouse and the animal feed product warehouse which are adjacent to the packaging area for each product. The capacity of PT XYZ's finished goods warehouse for flour products is 15,000MT, while the warehouse for animal feed products is 3,000 MT. The transfer of finished goods inventory from the packaging area to the warehouse area is carried out using robots and forklifts. The maximum shelf life of the product in the warehouse is 3 weeks from the production date. If the finished goods inventory is not sold and is not sent out of the warehouse, up to the maximum storage limit in the warehouse, then the finished goods inventory will be reprocessed (refloured) to become another product that meets company standards.

Some customers in certain cases carry out the process of loading packaged flour products, finished goods inventory, directly from the packaging production line via a special conveyor to the transporter truck, without using robots or forklifts. So that the product does not go through the storage process in the warehouse. Several other customers in certain cases can carry out the process of loading unpacked flour, work in progress inventory, directly from the production bin into a special flour tanker truck. So that the product does not go through the process of packaging and storage in the warehouse.

PT XYZ's finished goods inventory is monitored by the PPIC Department every day using daily documents from the warehouse departments: Daily Stock Warehouse

Flour and Warehouse By Product, Inventory Aging Warehouse Flour and Warehouse By Product (Daily), and Summary Stock Warehouse Flour (Daily). Based on the results of interviews with the PPIC Manager, there are two things that are monitored daily by the PPIC Department related to the inventory storage process, namely the product shelf life in the warehouse and the remaining warehouse capacity that can be used.

5.2 RESEARCH FINDINGS

Based on the results of interviews with several informants and the documents mentioned above, it can be concluded that the supply management constraints related to sales planning, production, and PT XYZ's raw material and resource requirements include : The difference between the weekly sales forecast and the weekly actual sales, causes an excess of idle finished goods inventory, makes the warehouse over capacity, and has the potential to make the shelf life of finished goods inventory in the warehouse exceed the maximum limit of 3 weeks. The actual weekly pick-up schedule is more than 11.32% different from the pick-up schedule at SPK originating from sales orders, potentially adding to outsourced labor costs for the process of transporting goods to vehicles and ineffective production due to repeated production schedule revisions to adjust with faster product delivery.

Broadly speaking, this is due to the accuracy of the monthly sales forecast which is reduced to an inaccurate weekly sales forecast. Based on the results of interviews with PT XYZ's Business Analyst and Factory Heads in Cilegon City, it is known that the pattern that often occurs in PT XYZ's sales is that actual sales in the first week to the third week of every month are often lower than the weekly sales forecast. Furthermore, in the third week, sales increased sharply to pursue the achievement of sales targets and Key Performance Indicator (KPI) targets. One method used is to provide discounts at the end of the month. Weekly sales forecasts are often considered to be intentional excess calculations. This statement is in line with the data in table 5.1, where even though the actual weekly sales in the January to June 2022 period were 817,496 packs higher than the weekly sales forecast. However, the level of accuracy is relatively low, because only 5% of weekly sales forecasts are accurate or equal to actual sales.

Apart from being caused by inaccurate weekly sales forecasts, the two inventory management problems related to sales planning, production, and the requirements for raw materials and resources above, are also caused by product delivery schedules that change and are often uncertain. So that it has an impact on changes in the production schedule. The Assistant Manager of the PPIC Department stated that the company's competitors which had the highest sales in Indonesia, experienced the same problems as PT XYZ but with a relatively low frequency, because it had more customers, larger warehouse capacity, and longer shelf life policy for finished goods inventory in the warehouse than PT XYZ.

Based on the results of interviews with the Main Director and Operational Director of PT XYZ, it is known that these two constraints are still acceptable to the company. This is related to the characteristics of the milling industry which has relatively low margins compared to other industries. Besides that, the company's goal in the first 10 years of production is to enlarge the captive market and compete with wheat flour producers whose production capacity is not far from PT XYZ. So as long as the monthly sales target is achieved, bringing in sufficient cash flow for the company's operations, and factory operations are still able to adjust the production process to deal with the two problems above, then the company does not require special action.

Suggestions for improvements that can be proposed for inventory management constraints related to sales planning, production, and PT XYZ's raw material and resource requirements are: (1) Using the SMA method to develop better sales forecasts, so that the level of accuracy of sales forecasts can be increased. This will have a direct impact on increasing the accuracy of the initial production plan. (2) Using the OEE value as a basis in preparing production plans so that they can adjust to machine conditions. So that the actual production becomes accurate, thereby reducing the number of sales order cancellations because the product is not available. (3) Make a buffer inventory based on the calculations in this study, so that PT XYZ has sufficient inventory to deal with sudden increases in demand, disruptions to the process of purchasing raw materials, or if there are problems with the effectiveness of production machines. Buffer inventory that is created can avoid excessive inventory levels in the warehouse which is at risk of exceeding the maximum inventory storage limit in the warehouse, which is 3 weeks. (4) Changing the measurement of sales targets in the KPI of the Sales Department, from all sales targets measured on an accumulated basis per month to a percentage of the progress of sales targets per week. Through these proposed improvements, it is hoped that the Sales Department will have a weekly sales progress target, so that it can provide better calculation weekly sales forecast data. Thus the delivery schedule can be arranged more accurately and reduce schedule changes. The impact is that the PPIC Department can prepare production plans more efficiently in monitoring buffer stock, aging-time processes, and fumigation processes; reduce the occurrence of excess warehouse capacity; and reduce the risk of product damage due to exceeding the maximum limit for storing products in the warehouse.

6. CONCLUSION AND RECOMMENDATION

Inventory management problems faced by PT XYZ are caused by the accuracy of the monthly sales forecast which is the basis for making inaccurate weekly sales forecasts and delivery schedules that do not match delivery schedules. The weekly sales forecast is calculated by adding up the purchase orders from customers that have been received with the projected value or forecast for the next week's sales, which is made using subjective estimates without precise calculations. PT XYZ experienced urgent production which was not contained in the initial production plan. PT XYZ's OEE value is inaccurate because it does not take into account the rework of products that are not fit for sale. The solution that has been implemented by PT XYZ is to shift the initial production schedule to receive urgent customer orders if the raw materials and production schedule are sufficient for the additional production. PT XYZ also makes buffer stocks with subjectively estimated amounts, without precise calculations. However, until now there have been cancellations of sales orders by customers due to the unavailability of goods ordered on the requested schedule, so that PT XYZ's production capacity is deemed unable to meet the soaring customer demand.

Suggested recommendations to fix these problems are to improve inventory management through making sales forecasts with objective calculations so as to produce more accurate forecast calculations. Improvements to the OEE calculation are needed so that PT XYZ can measure the effectiveness of the machines it has so that the production schedule can be realized at the planned time and quantity. PT XYZ can replace the buffer inventory calculation method with objective calculations so as to be able to produce a more accurate amount of buffer inventory in the face of fluctuations in customer demand. PT XYZ's inventory management based on inventory classification from largest to smallest useful value, will assist PT XYZ in making policies related to sales forecasts, production schedules, and buffer inventories. Besides that, PT XYZ can focus on allocating its resources to inventories that provide the greatest use value and provide a minimum allocation of resources for inventory management that provides the smallest use value. It is expected that PT XYZ can produce a low amount of finished goods inventory and be able to meet customer needs, while at the same time being able to calculate the required amount of work in progress inventory needed in a low amount. Based on the results of the research presented in the previous chapter, the following are recommendations for improving inventory management at PT XYZ: (1) Using the SMA method to prepare weekly sales forecasts, so that the level of accuracy of sales forecasts can be increased. (2) Improve the calculation of the OEE value by adding products that require rework due to damage to the packaging, as the number of products that are not fit for sale. (3) Create a buffer inventory based on the calculations in this study, so that PT XYZ has sufficient inventory to deal with sudden increases in demand, disruptions to the raw material purchasing process, constraints on the effectiveness of production machines and to avoid excess inventory levels in warehouses that are at risk of exceeding the maximum storage limit Inventory in warehouse is 3 weeks. (4) Changing the measurement of sales targets in the KPI of the Sales Department, from all sales targets measured on an accumulated basis per month to a percentage of the progress of sales targets per week.

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APPENDIX (IF ANY)

Provide the description in your article whether it is for image in your article, tables, variables, or formulas that you used. Here is an example of two appendix that probably used in the full text.

Appendix 1. Summary of PT XYZ Inventory

Inventory Type	Quantity	Storage	Storage Capacity
Finished Goods			
Flour Product	57		
39 product name, 1 packaging option		Flour Warehouse	15.000 MT
9 product name, 2 packaging option		1 Kg Flour Warehouse	1.500 MT
Feed Product	15	Feed Warehouse	3.500 MT
Total	**72**		
Work in Progress			
Base Flour	8	Base Flour Production Bin	500 MT
Unpack Flour	63	Production Machine Bin	2.000 MT
Total	**71**		

Appendix 2. Further Explanation on Variables

Category	Inventory Type	% Inventory Type	Usage Value (Rupiah)	% Usage Value
Category A	UJWO-120	18,31%	515.081.367.887	23,54%
	UBSU-110		283.286.602.699	12,95%
	UHKS-25		183.173.575.306	8,37%
	UJWR-25		158.742.633.284	7,25%
	IKWI-50		110.815.858.547	5,06%
	IIHA-25		100.442.010.608	4,59%
	UBSO-120		98.555.222.580	4,50%
	UJWR-110		68.747.845.541	3,14%
	UHBU-25		67.958.467.731	3,11%
	UJWRGB-25		48.605.889.962	2,22%
	IINR-25		44.172.762.220	2,02%
	UF010-25		42.964.303.212	1,96%
	UF05M-25		39.892.956.429	1,82%
	Cumulative			**80,54%**
Category B	UGEA-25	26,76%	32.483.489.023	1,48%
	UKRA-25		32.090.509.777	1,47%
	UBMH-110		23.742.145.396	1,08%
	UF06U-25		21.050.971.574	0,96%
	UGCO-25		19.998.962.256	0,91%
	IINI-25		19.536.648.243	0,89%
	IIHG38-25		18.874.425.910	0,86%
	UBMO-120		18.833.940.998	0,86%
	UGBM-25		17.298.788.890	0,79%
	UBSB-25		17.254.558.692	0,79%
	UROK-25		15.021.836.129	0,69%
	UF05-25		14.778.620.552	0,68%
	UBSM-25		13.669.224.093	0,62%
	UHKMA-25		12.879.951.339	0,59%
	UHKM-25		11.666.210.125	0,53%
	UGEH-25		11.549.180.434	0,53%
	IINIG30-25		9.150.493.388	0,42%
	UJWR-50		8.954.179.101	0,41%
	IINK-25		8.863.737.900	0,41%
	Cumulative			**14,97%**
Category C	39 Inventory type	55%	98.173.708.767	**4,49%**

Appendix 3. Comparation between Actual Sales and Sales Forecast

No.	Inventory Name	Actual Sales	Sales Forecast	Variance	Details of Weekly Sales											
					Actual Sales Equals to Forecast	No Actual Sales	Sales Occurred without Forecast	Actual Sales higher than Forecast					Actual Sales lower than Forecast			Total
								0,01-33,3 %	33,4-66,7 %	66,8-100 %	100,01 - 400 %	400,01 -1.652 %	0,01-33,3 %	33,4-66,7 %	66,8 - 100 %	
		(Metric Ton)			(Number of Week)											
1	UJWO-120	81.308	71.217	10.091	1	-	3	6	1	1	2	1	3	4	2	24
2	UBSU-110	33.319	23.841	9.478	-	-	3	5	3	-	2	1	9	1	-	24
3	UHKS-25	27.915	26.884	1.031	-	-	1	8	1	-	-	-	8	-	-	18
4	UJWR-25	27.784	29.200	(1.416)	-	-	-	7	2	-	1	-	11	4	-	25
5	IKWI-50	30.722	-	30.722	-	-	25	-	-	-	-	-	-	-	-	25
6	IIHA-25	19.429	10.004	9.425	-	-	1	1	2	-	13	3	3	2	-	25
7	UBSO-120	12.918	6.805	6.113	-	2	7	1	4	1	4	1	1	1	2	24
8	UJWR-110	10.409	13.911	(3.501)	-	-	3	-	2	-	1	1	3	7	7	24
9	UHBU-25	9.906	10.717	(811)	-	-	-	4	2	1	-	-	13	5	-	25
10	UJWRGB-25	8.426	6.048	2.378	1	1	9	2	-	2	1	-	3	1	2	22
11	IINR-25	7.491	4.547	2.944	-	4	4	2	2	1	2	4	3	2	1	25
12	UF010-25	7.515	5.996	1.519	-	-	-	11	6	3	-	-	4	1	-	25
13	UF05M-25	6.084	6.968	(884)	9	1	-	2	-	-	-	-	7	4	-	23
14	UGEA-25	4.555	5.503	(948)	-	-	1	4	1	-	-	-	10	8	1	25
15	UKRA-25	4.820	5.197	(377)	-	-	-	3	1	-	3	-	7	10	1	25
16	UBMH-110	3.447	7.194	(3.746)	-	-	3	2	-	-	-	1	2	6	10	24
17	UF06U-25	3.571	4.030	(460)	-	-	4	4	3	1	-	-	4	5	4	25
18	UGCO-25	2.666	3.071	(404)	-	-		7	-	1	-	-	9	6	2	25
19	IINI-25	3.005	248	2.757	-	2	15	-	-	-	2	-	1	-	-	20
20	IIHG38-25	2.590	-	2.590	-	-	16	-	-	-	-	-	-	-	-	16
21	UBMO-120	2.860	5.594	(2.734)	-	9	2	-	1	-	-	1	2	2	2	19
22	UGBM-25	2.926	3.081	(155)	-	-	3	2	2	1	1	-	8	8	-	25

Appendix 3. Comparation between Actual Sales and Sales Forecast (continued)

No.	Inventory Name	Actual Sales	Sales Forecast	Variance	Details of Weekly Sales											
					Actual Sales Equals to Forecast	No Actual Sales	Sales Occurred without Forecast	Actual Sales higher than Forecast					Actual Sales lower than Forecast			Total
								0,01-33,3 %	33,4-66,7 %	66,8-100 %	100,01 - 400 %	400,01 -1.652 %	0,01-33,3 %	33,4-66,7 %	66,8 - 100 %	
		(Metric Ton)			(Number of Week)											
23	UBSB-25	2.535	2.578	(43)	-	-	-	10	3	1	-	-	2	8	1	25
24	UROK-25	2.631	3.372	(741)	-	2	-	3	1	3	2	-	1	4	9	25
25	UF05-25	2.443	1.868	575	1	-	-	8	7	1	3	-	3	-	-	23
26	UBSM-25	2.284	1.357	927	-	-	11	4	-	-	2	-	-	6	2	25
27	UHKMA-25	2.126	1.578	548	3	2	1	-	-	4	6	1	2	3	1	23
28	UHKM-25	1.728	2.364	(636)	-	-	1	2	1	2	-	-	5	10	4	25
29	UGEH-25	1.688	2.297	(609)	-	1	-	6	1	1	-	-	4	8	4	25
30	IINIG30-25	1.455	64	1.391	-	2	6	-	-	-	2	2	-	-	-	12
31	UJWR-50	1.577	778	799	1	-	8	3	-	-	1	-	1	1	1	16
32	IINK-25	1.680	-	1.680	-	-	11	-	-	-	-	-	-	-	-	11
33	UHEM-110	873	1.842	(969)	-	-	3	-	-	-	-	1	1	10	9	24
34	UHHI-25	1.048	137	911	-	-	9	-	-	-	5	-	-	-	-	14
35	UGCH-25	974	484	490	-	-	15	1	-	-	1	-	1	6	1	25
36	IBKA-25	1.277	552	725	4	1	13	-	-	-	2	1	1	1	-	23
37	IKWICHN-50	1.632	-	1.632	-	-	4	-	-	-	-	-	-	-	-	4
38	UGBR-25	908	638	270	1	2	10	3	2	-	-	-	-	5	1	24
39	IIHB-25	1.016	66	950	-	-	15	-	-	-	2	1	-	1	-	19
40	UHBU-25	794	471	323	-	-	12	5	4	2	1	-	-	-	1	25
41	UHKU-25	728	485	243	2	-	8	-	2	1	2	2	-	2	2	21
42	UGEA-110	443	1.298	(855)	-	-	3	-	-	-	-	1	1	7	12	24
43	UF06H-25	681	568	113	-	3	11	1	1	-	-	-	2	4	2	24
44	UHKU-25	446	205	241	-	-	16	4	-	1	-	-	-	2	2	25

Appendix 3. Comparation between Actual Sales and Sales Forecast (continued)

No.	Inventory Name	Actual Sales	Sales Forecast	Variance	Details of Weekly Sales											
					Actual Sales Equals to Forecast	No Actual Sales	Sales Occurred without Forecast	Actual Sales higher than Forecast					Actual Sales lower than Forecast			Total
								0,01-33,3 %	33,4-66,7 %	66,8-100 %	100,01 - 400 %	400,01 -1.652 %	0,01-33,3 %	33,4-66,7 %	66,8 - 100 %	
		(Metric Ton)			(Number of Week)											
45	UF05MMG-25	565	260	305	2	-	10	-	1	1	1	-	-	2	-	17
46	UPPGG41-25	360	312		5	1	2	-	-	-	-	-	-	-	-	8
47	IINIG32-25	415	-	415	-	2	9	-	-	-	-	-	-	-	-	11
48	UDIS-50	320	240	80	4	-	2	-	-	-	-	-	-	-	-	6
49	UKBK-25	205	256	(51)	-	-	-	3	2	2	-	-	5	9	4	25
50	UF02M-25	334	335	(1)	-	4	2	-	-	-	-	-	1	2	1	10
51	UHBM-25	244	315	(71)	6	1	-	-	-	-	-	-	1	1	-	9
52	UF02-25	269	155	114	3	-	10	2	1	-	1	-	2	2	-	21
53	UPPG-25	120	120	-	2	-	-	-	-	-	-	-	-	-	-	2
54	UGBGM-25	189	42	147	-	2	11	2	-	1	-	1	-	1	-	18
55	IIHGC-25	160	-	160	-	-	6	-	-	-	-	-	-	-	-	6
56	UNJI-25	103	76	27	-	1	1	1	3	-	5	-	3	5	6	25
57	UTEMWH-20	68	-	68	-	-	8	-	-	-	-	-	-	-	-	8
58	UKRAH-25	129	53	76	1	-	16	-	-	-	-	-	-	-	2	19
59	IIHBS-25	160	30	130	1	-	2	-	-	-	-	-	-	-	-	3
60	UKBG-110	32	-	32	-	-	16	-	-	-	-	-	-	-	-	16
61	UF08-25	96	48	48	-	1	2	-	-	-	-	-	-	-	-	3
62	UTEMST-20	42	-	42	-	-	8	-	-	-	-	-	-	-	-	8
63	UKBG-25	32	22	10	-	1	2	1	1	-	5	1	3	5	6	25
64	UPPGMAX-25	48	48	-	2	-	-	-	-	-	-	-	-	-	-	2
65	UTEMYE-20	16	-	16	-	-	7	-	-	-	-	-	-	-	-	7
66	IBKB-25	35	-	35	-	-	4	-	-	-	-	-	-	-	-	4

Appendix 3. Comparation between Actual Sales and Sales Forecast (continued)

No.	Inventory Name	Actual Sales	Sales Forecast	Variance	Details of Weekly Sales											
					Actual Sales Equals to Forecast	No Actual Sales	Sales Occurred without Forecast	Actual Sales higher than Forecast					Actual Sales lower than Forecast			Total
								0,01-33,3 %	33,4-66,7 %	66,8-100 %	100,01 - 400 %	400,01 -1.652 %	0,01-33,3 %	33,4-66,7 %	66,8 - 100 %	
		(Metric Ton)			(Number of Week)											
67	IAYK-25	40	-	40	-	-	1	-	-	-	-	-	-	-	-	1
68	UTEMBAR-20	4	-	4	-	-	2	-	-	-	-	-	-	-	-	2
69	UHEM-25	8	-	8	-	-	3	-	-	-	-	-	-	-	-	3
70	UF09NJ-25	5	2	3	-	1	3	-	-	-	-	-	-	-	-	4
71	UTEMPRE-20	1	-	1	-	-	1	-	-	-	-	-	-	-	-	1
72	UKTP-25110	-	0,025	(0,025)	-	1	-	-	-	-	-	-	-	-	-	1
Total		348.632	275.368	73.216	49	47	385	130	63	32	73	24	150	182	105	

Appendix 4. Comparation between Actual Delivery Date and Delivery Schedule

Description	Total Sales Order	Customer Category General Trade		Customer Category Industri	
		Number of Sales Order	Percentage	Number of Sales Order	Percentage
Delivery date accordance with schedule	10.991	6.535	94,22%	2.362	66,01%
No delivery due to sales order cancelation	413	288	4,15%	41	1,15%
Delivery date earlier than schedule	1.278	24	0,35%	1.133	31,67%
Delivery date late from schedule	178	89	1,28%	42	1,17%
Total	12.860	6.936	100,00%	3.578	100,00%

Appendix 5.

Here are the calculation and selection of PT XYZ's weekly sales forecast method:

1. Determine the forecast timeframe, which is 12 weeks, so that the weekly sales forecast calculated in the study is for the 13th to the 25th week of 2022 for 71 PT XYZ products.
2. Using actual sales data for the 1st to 25th week of 2022 PT XYZ, to be processed using Microsoft Excel, so that the SMA, WMA and EMA values can be known for the sales forecast in the 13th to 25th week of the year 2022 for each of 71 products.
3. Calculating the MSE value of the sales forecast of each method on the 71 products calculated from the 3rd stage above. Calculation of the MSE value is done using Microsoft Excel.
4. Compare the MSE values of the 3 forecasting methods and determine the forecasting method with the lowest MSE value for each product.
5. Calculate the forecasting method that produces the lowest MSE value for each product and chooses that method to make a sales forecast for PT XYZ.

Appendix 6. Comparation of MSE Value

No.	Inventory Name	MSE Value (Package)			Smallest MSE Value per Product (Package)	Forecast Method Generate Smallest MSE Value per Product
		SMA Method	WMA Method	EMA Method		
1	54UJWO-120	3.753.868,41	3.975.308,59	3.931.176,43	3.753.868,41	SMA Method
2	05UBSU-110	428.973,09	420.622,06	425.277,55	420.622,06	WMA Method
3	34UHKS-25	477.844,03	491.301,06	480.954,09	477.844,03	SMA Method
4	50UJWR-25	194.006,43	218.281,09	197.698,99	194.006,43	SMA Method
5	71IKWI-50	181.914,47	184.232,92	171.127,08	171.127,08	EMA Method
6	43IIHA-25	94.169,68	95.255,09	88.021,55	88.021,55	EMA Method
7	07UBSO-120	184.098,37	181.627,13	180.206,47	180.206,47	WMA Method
8	52UJWR-110	149.738,38	140.965,33	121.369,75	121.369,75	EMA Method
9	35UHBU-25	16.760,64	16.173,30	17.223,74	16.173,30	WMA Method
10	53UJWRGB-25	60.835,55	67.043,97	62.937,91	60.835,55	SMA Method
11	49IINR-25	30.144,58	17.030,07	24.525,75	17.030,07	WMA Method
12	20UF010-25	15.304,03	16.142,55	15.357,75	15.304,03	SMA Method
13	15UF05M-25	21.801,66	17.702,47	19.320,65	17.702,47	WMA Method
14	27UGEA-25	5.321,01	5.702,79	5.633,69	5.321,01	SMA Method
15	59UKRA-25	10.380,82	10.558,35	10.175,88	10.175,88	EMA Method
16	02UBMH-110	16.368,37	17.103,02	16.275,29	16.275,29	SMA Method
17	17UF06U-25	10.483,03	10.013,36	9.535,51	9.535,51	EMA Method
18	25UGCO-25	1.769,05	1.715,24	1.657,84	1.657,84	EMA Method
19	45IINI-25	18.790,56	18.451,57	18.136,42	18.136,42	EMA Method
20	42IIHG38-25	14.944,60	15.937,55	16.073,99	14.944,60	SMA Method
21	03UBMO-120	48.622,26	52.574,02	51.081,28	48.622,26	SMA Method
22	22UGBM-25	3.045,89	3.006,77	3.094,07	3.006,77	WMA Method
23	04UBSB-25	4.031,68	4.170,99	4.147,96	4.031,68	SMA Method
24	65UROK-25	10.919,11	10.738,53	11.454,28	10.738,53	WMA Method
25	13UF05-25	3.873,14	4.190,16	3.943,11	3.873,14	SMA Method
26	06UBSM-25	8.049,68	8.315,29	7.866,32	7.866,32	EMA Method
27	38UHKMA-25	2.502,38	1.803,14	2.265,59	1.803,14	WMA Method
28	39UHKM-25	1.332,23	921,42	1.101,46	921,42	WMA Method
29	28UGEH-25	1.287,64	1.125,44	1.198,94	1.125,44	WMA Method
30	46IINIG30-25	5.551,58	3.985,60	4.499,70	3.985,60	EMA Method
31	51UJWR-50	2.482,26	3.098,39	2.197,80	2.197,80	EMA Method
32	48IINK-25	5.488,51	6.145,42	5.797,85	5.488,51	SMA Method
33	32UHEM-110	810,70	840,08	705,10	705,10	EMA Method
34	36UHHI-25	2.027,16	1.397,20	1.699,19	1.397,20	WMA Method
35	26UGCH-25	951,00	929,89	934,90	929,89	WMA Method
36	08IBKA-25	714,12	720,49	805,10	714,12	SMA Method
37	72IKWICHN-50	52.335,40	50.397,25	41.984,67	41.984,67	EMA Method
38	24UGBR-25	648,16	625,45	582,22	582,22	EMA Method
39	40IIHB-25	609,13	517,02	532,78	517,02	WMA Method
40	29UHBU-25	554,12	603,59	510,72	510,72	EMA Method
41	33UHKU-25	522,61	533,83	529,77	522,61	SMA Method
42	23UGEA-110	154,90	148,69	144,49	144,49	EMA Method
43	16UF06H-25	929,49	988,95	1.091,87	929,49	SMA Method

Appendix 6. Comparation of MSE Value (continued)

No.	Inventory Name	MSE Value (Package)			Smallest MSE Value per Product (Package)	Forecast Method Generate Smallest MSE Value per Product
		SMA Method	WMA Method	EMA Method		
44	37UHKU-25	85,40	92,06	92,59	85,40	SMA Method
45	14UF05MMG-25	665,29	569,30	611,83	569,30	WMA Method
46	63UPPGG41-25	533,85	569,61	611,89	533,85	SMA Method
47	47IINIG32-25	463,88	568,66	523,21	463,88	SMA Method
48	10UDIS-50	775,21	787,38	841,49	775,21	SMA Method
49	55UKBK-25	17,09	15,80	18,28	15,80	WMA Method
50	12UF02M-25	1.356,04	1.302,53	1.067,20	1.067,20	EMA Method
51	30UHBM-25	221,47	254,88	194,90	194,90	EMA Method
52	11UF02-25	70,32	75,58	77,49	70,32	SMA Method
53	62UPPG-25	8,62	0,57	6,17	0,57	WMA Method
54	21UGBGM-25	56,12	52,33	51,62	51,62	EMA Method
55	44IIHGC-25	52,78	39,89	43,19	39,89	WMA Method
56	61UNJI-25	27,03	27,91	29,64	27,03	SMA Method
57	69UTEMWH-20	18,53	19,99	20,29	18,53	SMA Method
58	60UKRAH-25	24,43	18,20	19,17	18,20	WMA Method
59	41IIHBS-25	201,07	169,46	191,07	169,46	WMA Method
60	57UKBG-110	2,86	2,86	3,11	2,86	SMA Method
61	18UF08-25	187,08	191,10	192,32	187,08	SMA Method
62	68UTEMST-20	14,64	15,21	15,72	14,64	SMA Method
63	56UKBG-25	3,97	4,17	4,27	3,97	SMA Method
64	64UPPGMAX-25	2,15	0,28	1,54	0,28	WMA Method
65	70UTEMYE-20	2,53	2,72	2,74	2,53	SMA Method
66	09IBKB-25	20,74	21,83	20,14	20,14	EMA Method
67	01IAYK-25	130,77	135,94	134,17	130,77	SMA Method
68	66UTEMBAR-20	0,36	0,37	0,37	0,36	SMA Method
69	31UHEM-25	1,90	2,01	1,95	1,90	SMA Method
70	19UF09NJ-25	0,17	0,18	0,18	0,17	SMA Method
71	67UTEMPRE-20	0,0199	0,0208	0,0206	0,0199	SMA Method
Number of Product with Smallest MSE Value in each method		32	20	19		

Appendix 7. The Result of Sales Forecast by Using Simple Moving Average Method

No	Inventory Name	Number of Week (Package)												
		13	14	15	16	17	18	19	20	21	22	23	24	25
1	54UJWO-120	3.433	3.461	3.759	2.944	3.055	3.248	3.324	3.577	3.388	3.362	2.921	2.922	2.977
2	05UBSU-110	1.377	1.380	1.236	1.064	1.118	1.185	1.230	1.272	1.280	1.335	1.231	1.143	1.296
3	34UHKS-25	977	1.039	1.055	1.073	1.103	1.148	1.181	1.206	1.303	1.354	1.271	1.181	1.276
4	50UJWR-25	1.092	1.114	1.068	1.102	1.088	1.115	1.108	1.100	1.139	1.135	1.129	1.073	1.092
5	71IKWI-50	1.342	1.355	1.330	1.370	1.351	1.286	1.278	1.309	1.276	1.297	1.238	1.122	1.112
6	43IIHA-25	850	853	830	778	768	845	828	830	824	823	775	694	681
7	07UBSO-120	536	553	492	377	445	500	427	466	435	436	390	360	457
8	52UJWR-110	432	435	389	250	253	302	349	405	467	478	452	437	419
9	29UHBU-25	33	30	31	27	29	30	29	32	35	32	32	30	29
10	35UHBU-25	438	443	394	400	400	397	384	367	382	394	391	362	355
11	53UJWRGB-25	329	339	379	380	340	348	358	368	363	349	345	361	361
12	49IINR-25	475	443	400	340	316	299	274	257	268	255	231	205	149
13	20UF010-25	276	272	263	267	267	278	294	299	319	325	320	308	326
14	15UF05M-25	303	327	326	324	329	342	329	303	282	270	251	218	202
15	27UGEA-25	190	198	186	173	164	167	172	166	174	178	171	161	172
16	59UKRA-25	215	223	223	202	180	197	208	206	215	178	170	159	157
17	02UBMH-110	125	157	146	136	137	141	152	170	155	171	168	156	160
18	17UF06U-25	133	138	139	132	129	125	118	108	117	123	121	122	144
19	25UGCO-25	102	104	104	99	83	92	96	103	109	114	117	111	111
20	45IINI-25	111	125	160	167	153	158	151	154	139	145	145	138	139
21	42IIHG38-25	92	95	87	99	112	122	132	119	123	149	134	113	99
22	03UBMO-120	94	94	90	90	86	138	138	111	141	144	144	117	117
23	22UGBM-25	137	136	123	126	117	118	110	107	109	117	109	102	101
24	04UBSB-25	93	102	98	94	90	94	96	104	118	117	117	108	113
25	65UROK-25	131	133	130	111	96	113	97	75	90	95	76	77	84
26	13UF05-25	97	103	105	106	106	102	103	107	109	119	109	96	99
27	06UBSM-25	107	114	102	95	92	84	107	110	112	102	100	99	80
28	38UHKMA-25	119	123	117	112	110	104	91	86	70	70	61	50	53
29	39UHKM-25	102	98	85	85	76	75	67	64	63	58	53	47	42
30	28UGEH-25	86	87	82	75	74	69	67	68	67	66	54	46	53
31	46IINIG30-25	95	84	68	54	38	38	29	25	4	4	-	-	13
32	51UJWR-50	48	48	48	56	64	75	70	68	73	69	70	74	82
33	48IINK-25	68	63	73	68	75	65	70	68	70	81	83	73	73
34	32UHEM-110	30	33	32	29	30	29	34	38	42	46	45	43	41
35	36UHHI-25	5	11	14	20	27	33	38	44	50	59	67	70	75
36	26UGCH-25	37	38	45	47	45	49	46	46	42	39	35	38	42
37	08IBKA-25	47	52	51	47	48	44	49	49	46	52	47	47	53
38	72IKWICHN-50	-	-	-	-	30	72	115	136	136	136	136	136	136
39	24UGBR-25	33	38	41	43	45	43	45	48	51	46	48	45	43
40	40IIHB-25	46	47	53	53	56	56	58	54	55	50	42	42	35
41	33UHKU-25	34	35	39	30	33	32	32	32	24	25	25	25	24
42	37UHKU-25	17	19	14	13	12	14	14	15	15	18	19	18	18
43	23UGEA-110	19	18	19	16	18	18	21	21	23	23	22	20	17
44	16UF06H-25	23	25	21	27	25	26	26	28	32	26	29	27	31
45	14UF05MMG-25	20	23	27	28	34	34	34	37	35	35	34	30	27
46	63UPPGG41-25	14	14	14	14	10	10	10	14	14	18	18	12	16
47	47IINIG32-25	17	17	14	14	14	17	20	20	18	15	15	15	15
48	10UDIS-50	7	13	13	13	13	17	17	20	20	13	13	17	20
49	55UKBK-25	10	10	10	10	9	9	8	9	9	7	7	7	7
50	12UF02M-25	16	27	27	27	23	22	22	21	21	21	21	21	10
51	30UHBM-25	10	9	9	10	10	10	10	10	10	10	10	10	10
52	11UF02-25	10	12	11	11	10	12	11	11	10	12	11	11	11
53	62UPPG-25	10	2	2	2	-	-	-	-	-	-	-	-	-
54	21UGBGM-25	10	9	10	10	12	12	12	13	13	5	5	5	5
55	44IIHGC-25	12	12	10	10	10	7	7	7	3	3	3	3	2

Appendix 7. The Result of Sales Forecast by Using Simple Moving Average Method (continued)

No	Inventory Name	Number of Week (Package)												
		13	14	15	16	17	18	19	20	21	22	23	24	25
56	61UNJI-25	3	4	3	4	4	4	4	5	5	5	5	4	4
57	69UTEMWH-20	3	2	3	3	3	3	2	2	3	2	2	2	2
58	60UKRAH-25	8	9	9	8	7	6	6	6	7	3	2	2	2
59	41IIHBS-25	6	8	11	11	13	13	13	13	9	9	9	8	8
60	57UKBG-110	1	1	1	1	2	2	2	2	2	2	2	2	1
61	18UF08-25	4	4	4	4	-	-	-	-	-	4	4	4	4
62	68UTEMST-20	2	1	2	2	2	2	2	2	2	2	2	2	2
63	56UKBG-25	1	1	1	1	1	1	1	2	2	2	2	1	1
64	64UPPGMAX-25	4	2	2	2	-	-	-	-	-	-	-	-	-
65	70UTEMYE-20	0	0	1	1	1	1	1	1	1	1	1	1	1
66	09IBKB-25	-	1	1	1	1	1	1	2	2	2	2	2	2
67	01IAYK-25	-	-	-	-	3	3	3	3	3	3	3	3	3
68	66UTEMBAR-20	0,17	0,17	0,17	0,17	0,17	0,17	-	-	0,18	0,18	0,18	0,18	0,18
69	31UHEM-25	-	0,08	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,67	0,67
70	19UF09NJ-25	0,29	0,17	0,17	0,17	0,17	0,29	0,29	0,13	0,13	0,13	0,13	0,13	0,13
71	67UTEMPRE-20	-	-	-	-	-	-	-	-	0,04	0,04	0,04	0,04	0,04

Appendix 8. Comparation between Actual Production and Initial Production Plan

No.	Inventory Name	Actual Production (Metric Ton)	Initial Production Plan (Metric Ton)	Variance (Metric Ton)	Details of Weekly Production (Number of Week): Actual Productio Equals to Initial Plan	No Actual Production	Production Occurred without Initial Plan	Actual Production higher than Initial Plan: 0,01-33,3 %	33,4-66,7 %	66,8-100 %	100,01 - 400 %	400,01 -1.652 %	Actual Production lower than Initial Plan: 0,01-33,3 %	33,4-66,7 %	66,8-100 %	Total
1	UJWO-120	87.400	62.200	25.200	1	-	1	2	1	2	7	-	5	3	2	24
2	UBSU-110	35.410	24.220	11.190	5	1	-	8	4	-	5	-	1	-	-	24
3	UHKS-25	27.420	28.974	(1.554)	1	-	-	8	1	-	-	-	15	-	-	25
4	UJWR-25	29.995	34.448	(4.453)	2	-	-	5	1	-	-	-	14	2	1	25
5	IIHA-25	21.065	27.405	(6.340)	-	-	-	-	-	-	-	-	18	7	-	25
6	UBSO-120	12.600	4.920	7.680	-	1	9	1	1	1	-	-	1	1	-	15
7	UJWR-110	11.360	5.140	6.220	1	2	6	-	1	-	3	1	2	2	-	18
8	UHBU-25	10.000	9.950	50	9	-	-	6	2	-	-	-	7	-	-	24
9	UJWRGB-25	8.730	8.809	(79)	2	2	3	2	2	1	-	2	3	6	-	23
10	IINR-25	7.320	8.220	(900)	-	1	2	3	-	1	-	-	4	5	3	19
11	UF010-25	7.435	6.750	685	9	-	-	3	4	2	1	-	2	3	-	24
12	UF05M-25	5.921	6.261	(340)	10	-	-	5	-	-	-	-	6	1	-	22
13	UGEA-25	4.435	5.175	(740)	11	-	-	-	-	-	1	-	6	6	-	24
14	UKRA-25	4.684	4.850	(166)	17	-	-	-	3	-	-	-	2	1	1	24
15	UBMH-110	3.525	935	2.590	2	-	8	-	1	1	-	-	-	-	-	12
16	UF06U-25	3.515	3.600	(85)	7	1	-	-	1	-	2	-	3	2	1	17
17	UGCO-25	2.734	3.347	(613)	13	5	-	2	1	-	-	-	3	-	-	24
18	IINI-25	2.818	2.080	738	3	2	4	2	-	4	1	-	-	1	-	17
19	IIHG38-25	2.347	1.200	1.147	3	-	7	3	-	-	1	-	-	1	-	15
20	UBMO-120	3.566	870	2.696	3	-	9	-	-	-	-	-	-	-	-	12
21	UGBM-25	2.900	3.480	(580)	8	2	1	3	-	-	-	-	4	4	-	22
22	UBSB-25	2.600	2.550	50	16	1	-	-	-	3	-	-	1	1	-	22

Appendix 8. Comparation between Actual Production and Initial Production Plan (continued)

No.	Inventory Name	Actual Production	Initial Production Plan	Variance	Details of Weekly Production										
					Actual Productio Equals to Initial Plan	No Actual Production	Production Occurred without Initial Plan	Actual Production higher than Initial Plan					Actual Production lower than Initial Plan		Total
								0,01-33,3 %	33,4-66,7 %	66,8-100 %	100,01 - 400 %	400,01 -1.652 %	0,01-33,3 %	33,4-66,7 %	66,8-100 %	
		(Metric Ton)			(Number of Week)											
23	UROK-25	2.725	2.300	425	4	6	5	-	1	4	-	-	-	1	-	21
24	UF05-25	2.550	2.300	250	20	-	1	-	1	1	-	-	-	-	-	23
25	UBSM-25	2.150	1.550	600	9	1	5	-	-	2	-	-	-	1	-	18
26	UHKMA-25	1.950	1.900	50	12	1	1	1	1	-	-	-	-	1	-	17
27	UHKM-25	1.730	1.764	(34)	12	2	-	-	-	2	-	-	-	2	-	18
28	UGEH-25	1.925	2.250	(325)	16	3	-	1	-	-	-	-	1	-	-	21
29	IINIG30-25	1.350	750	600	4	-	4	-	-	-	-	-	-	-	-	8
30	UJWR-50	1.811	1.504	307	4	-	1	3	-	-	-	-	1	-	-	9
31	IINK-25	1.730	710	1.020	3	1	8	1	-	1	1	-	1	-	-	16
32	UHEM-110	1.115	390	725	2	-	6	-	1	2	1	-	-	-	-	12
33	UHHI-25	1.160	1.060	100	5	1	4	-	-	-	-	-	1	-	-	11
34	UGCH-25	875	250	625	4	-	8	-	-	-	-	-	-	-	-	12
35	IBKA-25	1.306	723	583	7	-	8	-	-	-	-	2	1	-	1	19
36	UGBR-25	904	563	341	3	1	5	1	1	1	-	1	1	-	-	14
37	IIHB-25	996	184	813	1	-	6	1	-	-	-	-	1	-	-	9
38	UHBU-25	764	531	233	8	-	5	1	-	1	-	-	1	-	-	16
39	UHKU-25	629	439	191	5	-	2	2	1	-	1	-	-	-	-	11
40	UGEA-110	500	300	200	2	1	4	-	-	-	-	-	1	-	-	8
41	UF06H-25	626	151	475	2	-	8	-	-	-	-	-	-	-	-	10
42	UHKU-25	450	188	263	3	-	6	-	-	1	1	-	-	-	-	11
43	UF05MMG-25	580	470	110	4	1	2	-	-	-	1	-	-	-	-	8
44	UPPGG41-25	312	321	(9)	6	1	-	-	-	-	-	-	-	-	-	7

Appendix 8. Comparation between Actual Production and Initial Production Plan (continued)

No.	Inventory Name	Actual Production	Initial Production Plan	Variance	Details of Weekly Production: Actual Productio Equals to Initial Plan	No Actual Production	Production Occurred without Initial Plan	Actual Production higher than Initial Plan: 0,01-33,3 %	33,4-66,7 %	66,8-100 %	100,01 - 400 %	400,01 -1.652 %	Actual Production lower than Initial Plan: 0,01-33,3 %	33,4-66,7 %	66,8-100 %	Total
		(Metric Ton)			(Number of Week)											
45	IINIG32-25	415	-	415	-	-	7	-	-	-	-	-	-	-	-	7
46	UDIS-50	165	165	-	7	-	-	-	-	-	-	-	-	-	-	7
47	UKBK-25	195	102	93	1	-	8	1	2	-	-	-	3	1	-	16
48	UF02M-25	376	175	201	1	1	2	-	-	-	-	-	-	-	-	4
49	UHBM-25	211	213	(2)	4	-	-	-	-	-	-	-	1	-	-	5
50	UF02-25	286	206	80	9	-	2	-	-	-	1	-	-	-	-	12
51	UPPG-25	24	24	-	1	-	-	-	-	-	-	-	-	-	-	1
52	UGBGM-25	79	59	20	4	-	1	-	-	-	-	-	-	-	-	5
53	IIHGC-25	170	60	110	1	1	4	-	-	-	-	-	-	-	-	6
54	UNJI-25	99	66	33	2	-	4	1	-	-	-	-	1	1	-	9
55	UTEMWH-20	59	59	0	6	-	-	-	-	-	-	-	1	-	-	7
56	UKRAH-25	141	5	136	-	-	6	-	1	-	-	-	-	-	-	7
57	IIHBS-25	160	60	100	1	-	3	-	-	-	-	-	-	-	-	4
58	UKBG-110	36	-	36	-	-	2	-	-	-	-	-	-	-	-	2
59	UF08-25	96	-	96	-	-	2	-	-	-	-	-	-	-	-	2
60	UTEMST-20	37	38	(0)	6	-	-	-	-	-	-	-	1	-	-	7
61	UKBG-25	39	26	14	2	1	5	1	-	-	2	-	2	-	1	14
62	UPPGMAX-25	24	24	-	1	-	-	-	-	-	-	-	-	-	-	1
63	UTEMYE-20	16	16	0	5	-	-	1	-	-	-	-	-	-	-	6
64	IBKB-25	46	18	28	1	-	2	-	-	-	-	-	-	-	-	3
65	IAYK-25	40	-	40	-	-	2	-	-	-	-	-	-	-	-	2
66	UTEMBAR-20	4	4	0	1	-	-	1	-	-	-	-	-	-	-	2

Appendix 8. Comparation between Actual Production and Initial Production Plan (continued)

No.	Inventory Name	Actual Production	Initial Production Plan	Variance	Details of Weekly Production											
					Actual Productio Equals to Initial Plan	No Actual Production	Production Occurred without Initial Plan	Actual Production higher than Initial Plan					Actual Production lower than Initial Plan			Total
								0,01-33,3 %	33,4-66,7 %	66,8-100 %	100,01 - 400 %	400,01 -1.652 %	0,01-33,3 %	33,4-66,7 %	66,8-100 %	
		(Metric Ton)			(Number of Week)											
45	IINIG32-25	415	-	415	-	-	7	-	-	-	-	-	-	-	-	7
67	UHEM-25	8	4	4	1	-	1	-	-	-	-	-	-	-	-	2
68	UF09NJ-25	4	-	4	-	-	1	-	-	-	-	-	-	-	-	1
69	UTEMPRE-20	1	1	-	1	-	-	-	-	-	-	-	-	-	-	1
70	UKTP-25110	26	4	26	1	-	1	-	-	-	-	-	-	-	-	2
Total		328.674	277.308	51.371	315	40	192	69	32	30	29	6	115	53	10	

Appendix 9. Result of OEE Recalculation

Description	UoM	January	February	March	April	May	June
Total operational hour	Hour	744,0	672,0	616,0	584,0	640,0	744,0
Total operational hour without production	Hour	282,4	244,3	348,9	402,3	421,3	309,0
Regular maintenance	Hour	-	-	-	-	-	-
Iddle production schedule	Hour	-	24,0	216,0	304,0	304,0	8,0
Cleaning and changing material process	Hour	282,4	220,3	132,9	98,3	117,3	301,0
Total machine working hour	**Hour**	**461,6**	**427,8**	**267,1**	**181,8**	**218,7**	**435,0**
Total downtime hour	Hour	-	-	-	-	2,0	3,1
Downtime due to carrousel or packer damage	Hour	-	-	-	-	1,0	-
Downtime due to black out	Hour	-	-	-	-	1,0	3,1
Total actual machine working hour	**Hour**	**461,6**	**427,8**	**267,1**	**181,8**	**216,7**	**431,9**
Availability	**%**	**100,0**	**100,0**	**100,0**	**100,0**	**99,1**	**99,3**
Ideal production speed per minute 7,5 packages							
Ideal production speed per package 0,1333 minute							
Total unit produced	Package	196.400,0	184.640,0	114.760,0	78.585,0	93.197,0	187.964,0
Total ideal machine working hour	**Hour**	**436,4**	**410,3**	**255,0**	**174,6**	**207,1**	**417,7**
Total actual machine working hour	**Hour**	**461,6**	**427,8**	**267,1**	**181,8**	**216,7**	**431,9**
Performance	**%**	**94,6**	**95,9**	**95,5**	**96,1**	**95,6**	**96,7**
Total unit produced	**Package**	**196.400,0**	**184.640,0**	**114.760,0**	**78.585,0**	**93.197,0**	**187.964,0**
Total unit prouduksi non-good products	**Package**	**20,0**	**10,0**	**-**	**-**	**-**	**4,0**
Quality	**%**	**99,99**	**99,99**	**100,00**	**100,00**	**100,00**	**100,00**
OEE	**%**	**94,54**	**95,92**	**95,48**	**96,08**	**94,71**	**96,02**

Appendix 10. Result of Buffer Inventory Calculation

No.	Inventory Name	Z	z-score	PC	T_1	σ_D	σ_{LT}	D_{avg}	Buffer Inventory (Metric Ton)
1	54UJWO-120	0,95	1,65	2,0	1,0	1.087	0,82	1.195	3.004
2	05UBSU-110	0,95	1,65	2,0	1,0	172	0,82	200	484
3	34UHKS-25	0,95	1,65	2,0	1,0	66	0,82	191	300
4	50UJWR-25	0,95	1,65	2,0	1,0	102	0,82	214	374
5	07UBSO-120	0,95	1,65	2,0	1,0	282	0,82	317	785
6	52UJWR-110	0,95	1,65	2,0	1,0	144	0,82	113	369
7	35UHBU-25	0,95	1,65	2,0	1,0	47	0,50	82	128
8	53UJWRGB-25	0,95	1,65	2,0	1,0	140	0,82	181	407
9	20UF010-25	0,95	1,65	2,0	1,0	31	0,82	35	87
10	15UF05M-25	0,95	1,65	2,0	1,0	22	0,82	46	81
11	27UGEA-25	0,95	1,65	2,0	1,0	30	0,50	43	80
12	59UKRA-25	0,95	1,65	2,0	1,0	21	0,50	26	54
13	02UBMH-110	0,95	1,65	2,0	1,0	37	0,82	38	101
14	17UF06U-25	0,95	1,65	2,0	1,0	26	0,82	36	78
15	25UGCO-25	0,95	1,65	2,0	1,0	19	0,50	25	50
16	03UBMO-120	0,95	1,65	2,0	1,0	35	0,82	28	90
17	22UGBM-25	0,95	1,65	2,0	1,0	16	0,82	19	45
18	04UBSB-25	0,95	1,65	2,0	1,0	12	0,82	17	36
19	65UROK-25	0,95	1,65	2,0	1,0	82	0,82	73	216
20	13UF05-25	0,95	1,65	2,0	1,0	8	0,82	22	35
21	06UBSM-25	0,95	1,65	2,0	1,0	44	0,82	35	112
22	38UHKMA-25	0,95	1,65	2,0	1,0	8	0,82	22	35
23	39UHKM-25	0,95	1,65	2,0	1,0	11	0,50	18	30
24	28UGEH-25	0,95	1,65	2,0	1,0	15	0,50	21	39
25	32UHEM-110	0,95	1,65	2,0	1,0	17	0,82	29	56
26	36UHHI-25	0,95	1,65	2,0	1,0	66	0,82	191	300
27	23UGEA-110	0,95	1,65	2,0	1,0	15	0,82	22	46
28	16UF06H-25	0,95	1,65	2,0	1,0	12	0,82	15	35
29	37UHKU-25	0,95	1,65	2,0	1,0	9	0,50	12	22
30	55UKBK-25	0,95	1,65	2,0	1,0	2	0,50	2	5
31	61UNJI-25	0,95	1,65	2,0	1,0	4	0,82	3	10
32	60UKRAH-25	0,95	1,65	2,0	1,0	16	0,50	19	40
33	56UKBG-25	0,95	1,65	2,0	1,0	0,36	0,50	0,31	0,87
Total									7.533

Appendix 11.

Here are the steps in PT XYZ's buffer inventory calculation:

1. Determine the type of inventory that can be made into buffer inventory, which is only for flour products. While animal feed products are not made into a buffer inventory because apart from being a by-product, animal feed products also have a small number of customers, and the average production process is 1 day. Whereas for animal feed products IKWI-50 and IKWICHN-50 have a large number of customers so that production can continue without making buffer inventory calculations.
2. Determination of flour supplies that can be made into a buffer inventory, namely all flour products in category A in the ABC analysis, totaling 15 products; flour products in category B in the ABC analysis that have more than 1 customer and are fast moving and medium moving are 9 products. There is 1 flour product in category B that does not have a buffer inventory, because it only has 1 customer and is slow moving. Flour products in category C in the ABC analysis have more than 1 customer and there is continuous demand every 3 weeks for the last 3 months, namely 9 products. Meanwhile, for the other 23 products from category C in the ABC analysis, no buffer inventory was made because each is a made-to-order product from 1 customer.
3. Determination of the service level value, namely 95% which is the actual production achievement target of the total production plan of the PT XYZ Factory in Cilegon. The service level value was obtained from interviews with the Assistant Manager of the PPIC Department and from the PPIC Department's key performance indicator document,
4. Determination of the service factor value obtained from the z-score table at a service level of 95%, namely 1.65.
5. Determination of the production cycle value obtained from 1 day of the production cycle plus 1 day of storage in the warehouse, so that the value of the production cycle is 2.
6. Determination of the time increment value, which is obtained from the average daily inventory usage basis, so that a time increment value of 1 is obtained.
7. Calculation of the standard deviation value of the production lead time for each variant of the PT XYZ product lead time using Microsoft Excel. Flour products containing high protein have a production lead time of 7 to 8 days, so the standard deviation value of the lead time is 0.5. Whereas flour products other than those containing high protein, have production lead times between 1 to 3 days, so the standard deviation value of the lead time is 0.82.
8. Calculation of the buffer inventory value using the equation presented in literature review. The standard deviation value of demand and the average value of demand are presented in metric tons.