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Raw Material Inventory Control Using Probabilistic Methods and P Models as an Effort to Reduce the Risk of Out of Stock at UD XYZ

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ABSTRACT

The calculation of raw material inventory for pentol frozen products at UD XYZ using the probabilistic P Model Back Order indicates that the application of this method effectively helps the company optimize its inventory control. The probabilistic approach provides more accurate considerations in determining order quantities, order intervals, and minimizing the risk of stock shortages. The results show that beef reaches its optimal point with orders placed every 3 days at a quantity of 278.24 kg and a total cost of Rp 9,705,474, with a service level of 75%. Chicken also achieves optimal results with an order interval of every 3 days at 109.05 kg and a total cost of Rp 1,481,784 with an 80% service level. For sago flour, optimal inventory performance is achieved with orders every 6 days totaling 152.58 kg at a cost of Rp 946,617 and a service level of 76%. Meanwhile, tapioca flour reaches its optimal point with orders every 6 days amounting to 76.02 kg, a total cost of Rp 200,186, and an 81% service level. Overall, the application of the probabilistic P Model Back Order has proven to produce an efficient and measurable inventory system that supports the smooth production process of pentol frozen products at UD XYZ.

1. Introduction

The frozen food processing industry is a sector that has experienced rapid growth in recent years. Increasingly dynamic lifestyle changes and demands for convenience, especially in urban areas, have led to increased consumption of fast food products that are hygienic and have a long shelf life [1]. One popular frozen food product is frozen meatballs, a type of small meatball-like food that is frozen to maintain quality and extend its shelf life. This product is popular because it is easy to prepare, affordable, and flexible in serving, whether steamed, fried, or boiled [1].

UD XYZ is a business that produces frozen meatballs using a Make-to-Order (MTO) production system. With this system, the company only produces when demand arrives, making raw material availability a crucial component in maintaining a smooth production process. Suboptimal raw material inventory management can hamper production and reduce the company's ability to meet consumer demand [2], [3].

The main problem faced by UD XYZ is inaccurate raw material inventory management, as evidenced by frequent out-of-stock situations. This lack of raw material availability not only hampers production flow but also reduces the company's ability to meet consumer demand in a timely manner. As a result, the company potentially experiences losses in the form of lost sales opportunities, decreased customer trust, and increased operational costs due to production rescheduling. This out-of-stock phenomenon indicates that the current inventory control system is unable to respond to demand uncertainty, fluctuations in raw material consumption, and irregularities in the ordering process. In other words, UD XYZ does not yet have an accurate inventory planning mechanism to determine when to reorder, how much to order, and what level of safety stock is needed to anticipate variability in production needs [4], [5], [6].

Based on these issues, this study aims to analyze and optimize raw material inventory management at UD XYZ, including the amount of material required, the amount of actual usage, and the costs incurred in the procurement process. Optimization is carried out by determining the appropriate ordering time, the optimal order quantity, and the required level of safety stock [7], [8], [9].

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To achieve these objectives, this study uses the Probabilistic Model P Method, an inventory management approach to determine ordering intervals, optimal order quantities, safety stock requirements, and total inventory costs. The application of this method is expected to provide recommendations for a more effective inventory control system, enabling optimal production processes and enabling companies to consistently meet demand. However, based on a literature review, most research on small businesses and home industries still focuses on deterministic methods such as EOQ or simple, experience-based approaches, which fail to accurately capture demand variability and supply uncertainty. Research applying the probabilistic Model P, particularly for small businesses like UD XYZ, is still very limited. Therefore, the selection of the probabilistic Model P method in this study is based on this research gap.

The novelty of this research lies in the application of the Probabilistic Model P Method in the context of the frozen meatball home industry, which generally does not yet employ a probabilistic-based inventory control approach [4,] [7], [10]. While most small businesses still rely on simple calculations or subjective experience, this study offers a quantitative approach that is able to determine the optimal ordering interval, economic order quantity, and safety stock level more accurately based on actual demand variability [11]. Thus, this study not only addresses the problem of raw material shortages, but also provides a practical contribution in the form of a more measurable inventory control model that can be implemented directly to improve the production efficiency of UD XYZ.

2. Research methods

This research method uses a probabilistic approach to determine optimal inventory levels and ordering intervals. The data processing process is carried out in stages, starting with processing demand data, identifying distribution parameters, and determining the input values required for the probabilistic model. The data processing stages can be seen in the flowchart in Figure 1 below.

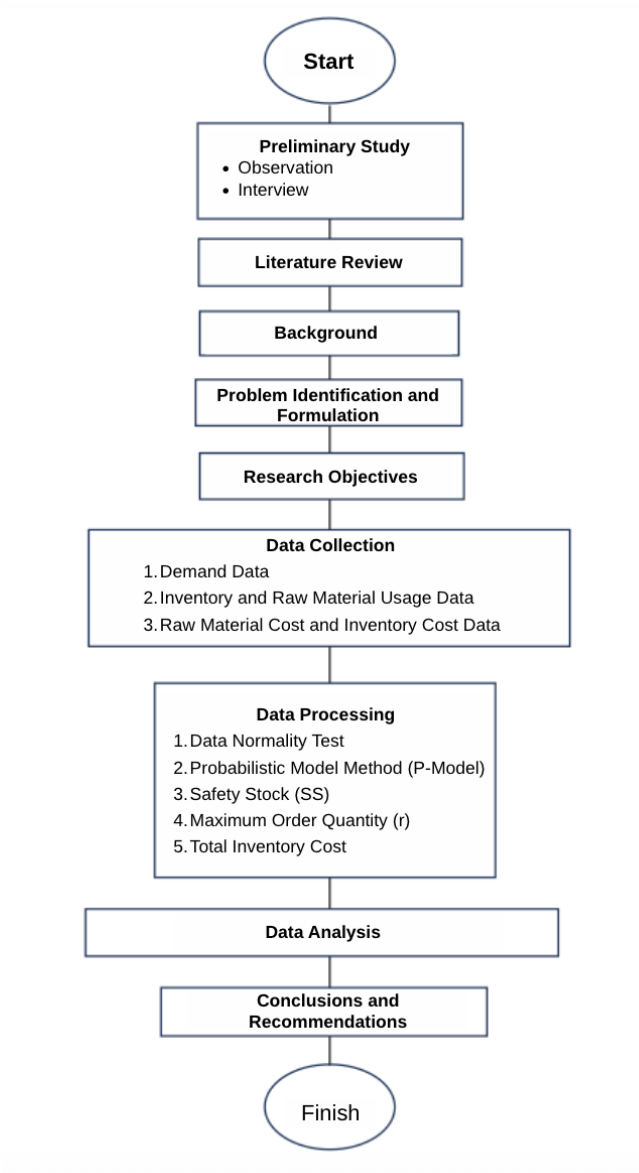

Figure 1 Research Flowchart

2.1 Field Study

A field study was conducted directly at UD XYZ. This study revealed a real problem in inventory management, namely out-of-stocks in four raw materials: beef, chicken, sago flour, and tapioca flour. This situation resulted in suboptimal production.

2.2 Problem Identification

This problem identification, based on the results of a field study conducted at UD XYZ and a literature review related to inventory management, reveals that the company still faces various challenges in managing raw materials. The main problem is frequent out-of-stocks for four raw materials: beef, chicken, sago flour, and tapioca flour.

2.3 Data Collection

The data collection techniques used in this study are:

1. Interview Technique

An interview is a direct information gathering method that involves interaction between the researcher and relevant parties, either in person or via telephone, with the aim of obtaining data related to the research topic.

2. Field Observation Technique

This study utilizes primary data related to the objects directly observed. The approach used is based on observation or data collection techniques, where direct observation provides information on the use of raw materials in the production process.

2.4 Data Processing

The data processing in this study was conducted using a probabilistic approach to determine optimal inventory levels and ordering intervals. The data processing was carried out in stages, starting with processing demand data, identifying distribution parameters, and determining the input values required for the probabilistic model. The data processing stages are as follows:

2.4.1 Data Normality Test

Before performing calculations using probabilistic methods, the initial step is to perform a normality test on the research data. This test is performed to ensure that the collected data follows a normal distribution, thus meeting the basic assumptions required in parametric statistical analysis. Meeting the normal distribution is crucial because various parametric statistical techniques require normal data for reliable and valid analysis results. Therefore, the normality test is a crucial step in ensuring the validity of subsequent analysis methods and providing a strong foundation for objective and scientific interpretation of research results.

2.4.2 Performing Maximum Order Calculations

After conducting data testing, the next step is to calculate optimal inventory by determining (To) the time period between orders, (Qo) optimal inventory, and (SS) safety stock.

2.4.3 Performing Total Cost Calculations

After obtaining the calculation results regarding the maximum order quantity, the next step is to calculate the total inventory cost. This total cost calculation includes ordering costs, storage costs, and potential inventory shortage costs that may occur during a certain period [13]. By calculating all these cost components, the company can determine the amount of expenses arising from the inventory policy used and ensure that the selected ordering decision is the most efficient alternative and is able to support the smooth running of the production process [14].

2.4.4 Conducting Control and Inventory Analysis

After the probabilistic calculation, the optimal number of raw material orders and total cost values were obtained, the next stage in this research is to conduct a comprehensive analysis. The analysis is carried out by comparing the total costs incurred by the company currently with the total costs calculated using the Probabilistic P Back Order Method. This comparison aims to assess the effectiveness of the Probabilistic P Back Order Method in reducing inventory costs. Furthermore, the calculation results show optimal results that are in accordance with the capacity of ordering needs and low costs [15]. Thus, the research not only produces numerical calculations, but also provides a strong basis for managerial decision making related to cost optimization and inventory management efficiency.

2.4.5 Conducting Total Cost and Revenue (Turnover) Analysis

Conducting an analysis of total costs and revenue aims to determine the extent to which the inventory policy implemented is able to provide optimal profits for the company [16]. In this analysis, the total cost of ordering, which includes purchasing, storage, and potential inventory shortages, is compared with the revenue generated from product sales. Through this comparison, the company can assess the level of operational efficiency and determine whether the ordering strategy used is able to maximize profits or whether improvements still need to be made.

3. Results and Discussion

3.1 Data Normality Test

Testing was conducted on four main types of raw materials used by UD. XYZ, namely Beef, Chicken, Sago Flour, and Tapioca Flour. Each raw material was tested for its distribution pattern based on usage data during the January 2025 period. From the results of data processing with Minitab, a distribution pattern graph was obtained for each raw material which showed a tendency for data distribution towards a normal distribution line. The test result graph illustrates how raw material usage data [12]. Thus, the visualization results from Minitab are the basis for determining whether raw material usage data at UD. XYZ is worthy of further analysis using a probabilistic approach. The following Figures 2, 3, 4, and 5 are the results:

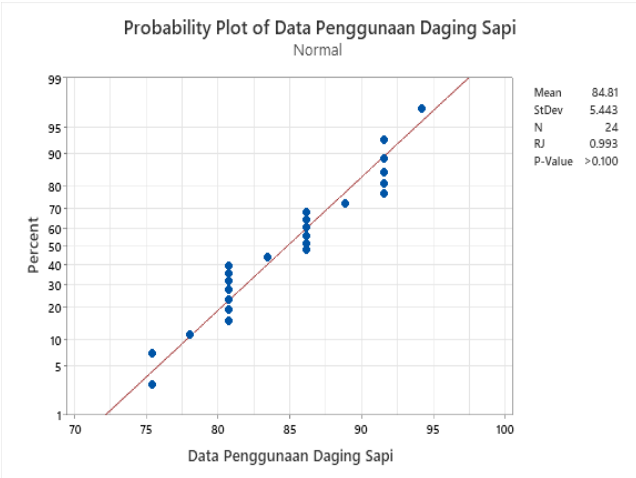

Figure 2 Normality Test of Beef Data

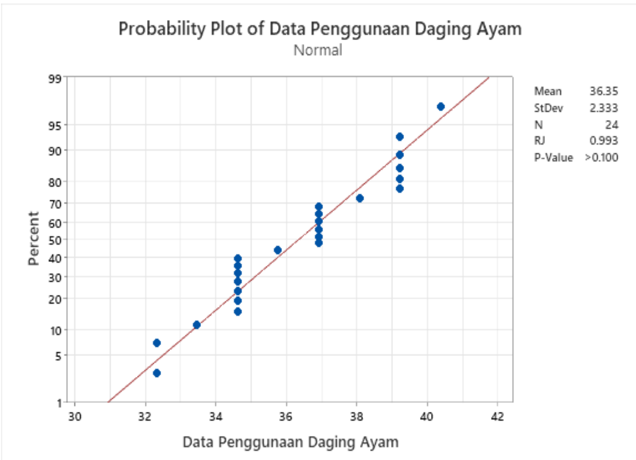

Figure 3 Normality Test of Chicken Meat Data

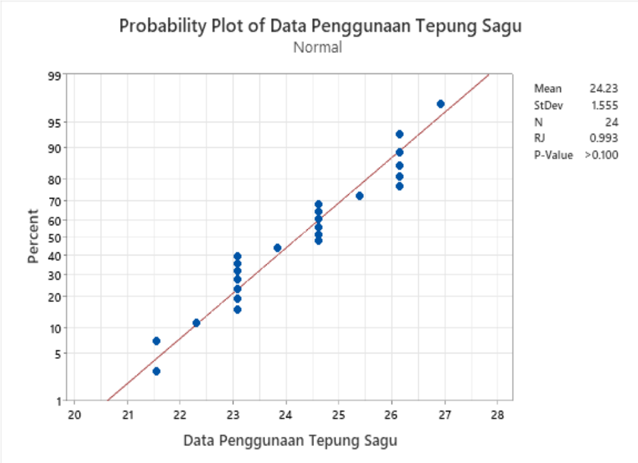

Figure 4 Normality Test of Sago Flour Data

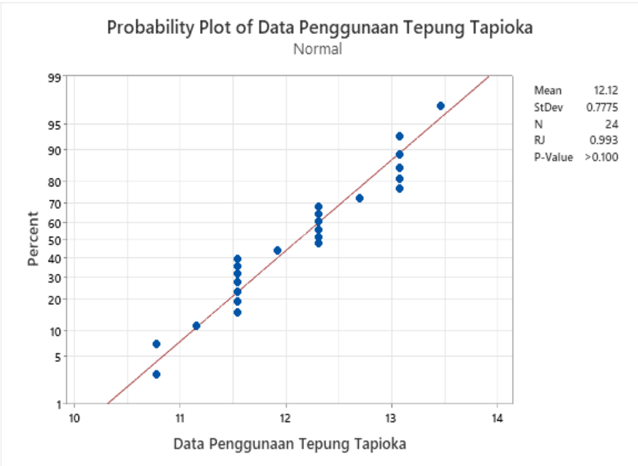

Figure 5 Normality Test of Tapioca Flour Data

3.2 *Probabilistic Calculation of P Back Order*

Once all the necessary parameters are known, the next step is to perform calculations using the probabilistic P method with backorders. This method aims to determine the most optimal inventory policy by calculating several key formulas: the time between orders (T), the maximum inventory quantity (R), and the optimal total inventory cost (OT).

3.2.1 *Beef*

a. Calculating the time between orders (T_o)

The third iteration subtracts the T_o value. If the T_o value calculated in iteration 2 is 0.166, then ΔTo is subtracted by 0.067, resulting in the new T_o value used as a reference for the beef iteration 3 process of 0.099, or 3 days.

b. Calculating the value of *a* (Possible Shortage)

The second step is to calculate the value of a. After obtaining the value of *a*, the next step is to find the values of F(*Za*), ψ, and *Za*.

$$a = \frac{Th}{Cu}$$
$$= \frac{3 \times Rp.1.839}{Rp.1.000.000} = \frac{Rp.5.517}{Rp.1.000.000} = 0{,}0055$$

The result of a is 0.0055, so the value of F(*Za*) = 0.0175, ψ = 0.0020, and *Za* = 2.50.

c. Calculating the R (Maximum Inventory)

Value The third step involves a calculation to determine the maximum inventory value, or R. This R value is obtained by adding the optimal order quantity (qo) and the safety stock (ss).

$$qo = DT$$
$$= 84.81kg \times 3$$
$$= 254{,}43kg$$

The size of the beef order is 254.43 kg/3 days

$$ss = D_L + Z_a \sqrt[s]{T+L}$$
$$= 84{,}81kg \times 0{,}0055 + 2{,}50 \times 5{,}4\sqrt{3 + 0{,}0055}$$
$$= 0{,}466 + (2{,}50 \times 5{,}4 \times 1{,}73)$$
$$= 0{,}466 + 23{,}35$$
$$= 23{,}81kg$$

The size of the safety stock of beef is 23.81 kg.

$$R = (qo + ss)$$
$$= (254{,}43kg + 23{,}81kg)$$
$$= 278{,}24kg$$

The maximum beef supply yield is 278.24 kg/3 days.

d. Calculate the value of N

The fourth step will be a calculation to determine the number of shortages in units or the N value, which serves as the basis for calculating the total inventory cost.

$$N = S\sqrt{T+L} \times \{\{f(Z_a) - Z_a\, x \times \psi(Z_a)\}$$
$$= 5{,}4\sqrt{3 + 0{,}0055}\ \{\{0{,}0175 - (2{,}50 \times\ 0{,}0020)\}$$
$$= 5{,}4\sqrt{3 + 0{,}0055} \times (0{,}0175 - 0{,}005)$$
$$= 5{,}4\sqrt{3 + 0{,}0055} \times\ 0{,}012$$
$$= 5{,}4\ \times 1{,}733 \times\ 0{,}012$$
$$= 0{,}112kg$$

The result of the shortage in beef units is 0.112 kg

e. Calculating total cost (OT)

The fifth step is to calculate the total cost. This total cost calculation is done using the following formula.

$$OT = D_P + \frac{A}{T} + h\left(R - D_L + \frac{D_T}{2}\right) + \frac{C_u}{T}N$$
$$= (84{,}81kg \times Rp.105.000) + \left(\frac{Rp.55.000}{3}\right) + (Rp.1.839 \times \left(279{,}24kg - (84{,}81kg \times 0{,}0055) + \left(\frac{84{,}81kg \times 3}{2}\right)\right) + \frac{Rp.1.000.000}{3} \times 0{,}112kg$$
$$= Rp.8.905.050 + Rp.18.333 + Rp.744.758 + Rp.37.333$$
$$= Rp.9.705.474$$

The result of the total cost calculation ($O_T = O_b + O_p + O_s + O_k$) of beef is Rp. 9,705,474

f. Calculating the level of service (η)

The final step is to calculate the service level, using the following formula:

$$\eta = 1 - \frac{N}{DL}$$
$$= 1 - \frac{0{,}112kg}{84{,}81kg \times 0{,}0055}$$
$$= 1 - \frac{0{,}112kg}{0{,}466kg}$$
$$= 1 - 0{,}240343$$
$$= 0{,}75 = 75\%$$

The result of the calculation of the level of beef service is 75%.

3.2.2 Chicken Meat

a. Calculating the time between orders (T_o)

In the third iteration, the T_o value is reduced. If the T_o value obtained from the calculation results in iteration 2 is 0.166, then ΔTo is reduced by 0.067, so that the new T_o value used as a reference for processing iteration 3 of chicken meat is 0.099, which is 3 days.

b. Calculating the value of *a* (Possible shortfall)

The second step will be to calculate the value of a. After getting the value of a, then find the value of F(Za), ψ, Za.

$$a = \frac{Th}{Cu}$$
$$= \frac{3 \times Rp.4.291}{Rp.500.000}$$
$$= \frac{Rp.12.873}{Rp.500.000}$$
$$= 0{,}0257$$

The result of a is 0.0656, so the value of F(Z*a*) = 0.0656, ψ = 0.0111, and Z*a* = 1.90.

c. Calculating the R value (Maximum inventory)

The third step will be a calculation process to determine the maximum inventory value or R. This R value is obtained from the sum of the optimal order quantity (qo) and safety stock (ss).

$$qo = DT$$
$$= 36{,}35kg \times 3$$
$$= 109{,}05kg$$

The size of the chicken meat order is 109.05 kg/3 days

$$ss = D_L + Z_a \sqrt[s]{T + L}$$
$$= 36{,}35kg \times 0{,}0257 + 1{,}90 \times 2{,}3 \sqrt{3 + 0{,}0257}$$
$$= 0{,}93 + (1{,}90 \times 2{,}3 \times 1{,}73)$$
$$= 0{,}93 + 7{,}56$$
$$= 8{,}49kg$$

The safety stock size of chicken meat is 8.49 kg.

$$R = (qo + ss)$$
$$= (109{,}05kg + 8{,}49kg)$$
$$= 117{,}54kg$$

The maximum stock of chicken meat is 117.54 kg/3 days.

d. Calculate the value of N

Next, a calculation will be carried out to determine the number of shortages in units or the N value, which serves as the basis for calculating the total inventory cost.

$$N = S\sqrt{T + L} \times \{\{f(Z_a) - Z_a\, x \times \psi(Z_a)\}$$
$$= 2{,}3\sqrt{3 + 0{,}0257} \times \{\{0{,}0656 - (1{,}90 \times 0{,}0111)\}$$
$$= 2{,}3\sqrt{3 + 0{,}0257} \times (0{,}0656 - 0{,}021)$$
$$= 2{,}3\sqrt{3 + 0{,}0257} \times 0{,}045$$
$$= 2{,}3 \times 1{,}73 \times 0{,}045$$
$$= 0{,}179kg$$

The result of the shortage in chicken meat units is 0.179 kg

e. Calculating total cost (OT)

The final step is to calculate the total cost. This total cost calculation is done using the following formula.

$$OT = D_P + \frac{A}{T} + h\left(R - D_L + \frac{D_T}{2}\right) + \frac{C_u}{T} N$$
$$= (36{,}35kg \times Rp.32.000) + (\frac{Rp.55.000}{3}) + (Rp.4.291 \times \left(117{,}54kg - (36{,}35kg \times 0{,}0257) + \left(\frac{36{,}35kg \times 3}{2}\right)\right) + \frac{Rp.500.000}{3} \times 0{,}179kg$$
$$= Rp.1.163.200 + Rp.18.333 + Rp.270.418 + Rp.29.833$$
$$= Rp.1.481.784$$

The result of the total cost calculation ($O_T = O_b + O_p + O_s + O_k$) of chicken meat is Rp. 1,481,784.

f. Calculating the level of service (η)

In this step in calculating the service level, the formula is as follows:

$$\eta = 1 - \frac{N}{DL}$$
$$= 1 - \frac{0{,}179kg}{36{,}35kg \times 0{,}0257}$$
$$= 1 - \frac{0{,}179kg}{0{,}934kg}$$
$$= 1 - 0{,}191648$$
$$= 0{,}80 = 80\%$$

The results of the calculation of the level of chicken meat service are 80%.

3.2.3 Sago Flour

a. Calculating the time between orders (T_o)

In the third iteration, the T_o value is reduced. If the T_o value obtained from the calculation results in the second iteration is 0.333, then ΔTo is reduced by 0.134, so that the new T_o value used as a reference for the processing of iteration 3 of sago flour is 0.199, which is 6 days.

b. Calculating the value of a (Possible shortfall)

The second step will be to calculate the value of a. After getting the value of a, then find the value of F(Za), ψ, Za.

$$a = \frac{Th}{Cu}$$
$$= \frac{6 \times Rp.1.238}{Rp.200.000}$$
$$= \frac{Rp.7.428}{Rp.200.000}$$
$$= 0{,}0371$$

The result of a is 0.0371, so the value of F(Za) = 0.0863, ψ = 0.0162, and Za = 1.75.

c. Calculating the R value (Maximum inventory)

The third step will be a calculation process to determine the maximum inventory value or R. This R value is obtained from the sum of the optimal order quantity (qo) and safety stock (ss).

$$qo = DT$$
$$= 24{,}23kg \times 6$$
$$= 145{,}38kg$$

The order size for sago flour is 145.38 kg/6 days

$$ss = D_L + Z_a \sqrt[s]{T + L}$$
$$= 24{,}23kg \times 0{,}0371 + 1{,}75 \times 1{,}5 \sqrt{6 + 0{,}0371}$$
$$= 0{,}89 + (1{,}75 \times 1{,}5 \times 2{,}45)$$
$$= 0{,}89 + 6{,}431$$
$$= 7{,}2kg$$

The safety stock size of sago flour is 7.2 kg.

$$R = (qo + ss)$$
$$= (145{,}38kg + 7{,}2kg)$$
$$= 152{,}58kg$$

The maximum stock of sago flour is 152.58 kg/6 days.

d. Calculate the value of N

Next, a calculation will be carried out to determine the number of shortages in units or the N value, which serves as the basis for calculating the total inventory cost.

$$N = S\sqrt{T + L} \times \{\{f(Z_a) - Z_a\, x \times \psi(Z_a)\}$$
$$= 1{,}5\sqrt{6 + 0{,}0371} \times \{\{0{,}0863 - (1{,}75 \times 0{,}0162)\}$$
$$= 1{,}5\sqrt{6 + 0{,}0371} \times (0{,}0863 - 0{,}028)$$
$$= 1{,}5\sqrt{6 + 0{,}0371} \times 0{,}058$$
$$= 1{,}5 \times 2{,}45 \times 0{,}058$$
$$= 0{,}213kg$$

The result of the shortage in sago flour units is 0.213 kg

e. Calculate the total cost

The final step is to calculate the total cost. This total cost calculation is done using the following formula.

$$OT = D_P + \frac{A}{T} + h\left(R - D_L + \frac{D_T}{2}\right) + \frac{C_u}{T} N$$
$$= (24{,}23kg \times Rp.35.000) + (\frac{Rp.10.000}{6}) + (Rp.1.238 \times \left(152{,}58kg - (24{,}23kg \times 0{,}0371) + \left(\frac{24{,}23kg \times 6}{2}\right)\right) + \frac{Rp.200.000}{6} \times 0{,}213kg$$
$$= Rp.848.050 + Rp.1.666 + Rp.97.802 + Rp.7.099$$
$$= Rp.946.617$$

The result of the total cost calculation ($O_T = O_b + O_p + O_s + O_k$) of sago flour is Rp. 946,617.

f. Calculating the level of service

The final step is to calculate the service level, using the following formula:

$$\eta = 1 - \frac{N}{DL}$$
$$= 1 - \frac{0{,}213kg}{24{,}23kg \times 0{,}0371}$$
$$= 1 - \frac{0{,}213kg}{1{,}898kg}$$
$$= 1 - 0{,}237193$$
$$= 0{,}76 = 76\%$$

The results of the calculation of the level of service of sago flour are 76%.

3.2.4 Tapioca Flour

a. Calculating the time between orders (T_o)

In the third iteration, the T_o value is reduced. If the T_o value obtained from the calculation results in iteration 2 is 0.333, then ΔTo is reduced by 0.134, so that the new T_o value used as a reference for working on iteration 3 of tapioca flour is 0.199, which is 6 days.

b. Calculate the value of a (Possible shortage)

Next, a calculation will be carried out to find the value of *a*. After getting the value of a, then find the value of F(Z_a), ψ, Za.

$$a = \frac{Th}{Cu}$$
$$= \frac{6 \times Rp.2.475}{Rp.200.000}$$
$$= \frac{Rp.14.850}{Rp.200.000}$$
$$= 0{,}0742$$

The result of a is 0.0742, so the value of F(Za) = 0.1497, ψ = 0.0367, and Za = 1.40.

c. Calculating the R value (Maximum inventory)

Next, a calculation process will be performed to determine the maximum inventory value, or R, which serves as the upper limit for the amount of stock that must be available in the warehouse. This R value is obtained by adding the optimal order quantity (qo) and the safety stock (ss).

$$qo = DT$$
$$= 12{,}12kg \times 6$$
$$= 72{,}72kg$$

The order size for tapioca flour is 72.72 kg/6 days

$$ss = D_L + Z_a \sqrt[s]{T + L}$$
$$= 12{,}12kg \times 0{,}0742 + 1{,}40 \times 0{,}7 \sqrt{6 + 0{,}0742}$$
$$= 0{,}89 + (1{,}40 \times 0{,}7 \times 2{,}46)$$
$$= 0{,}89 + 2{,}41$$
$$= 3{,}3kg$$

The safety stock size of tapioca flour is 3.3 kg.

$$R = (qo + ss)$$
$$= (72{,}72kg + 3{,}3kg)$$
$$= 76{,}02kg$$

The maximum inventory of tapioca flour is 76.02 kg/6 days.

d. Calculate the value of N

Next, a calculation will be carried out to determine the number of shortages in units or the N value, which serves as the basis for calculating the total inventory cost.

$$N = S\sqrt{T + L} \times \{\{f(Z_a) - Z_a \, x \times \psi(Z_a)\}$$
$$= 0{,}7\sqrt{6 + 0{,}0742} \times \{\{0{,}1497 - (1{,}40 \times 0{,}0367)\}$$
$$= 0{,}7\sqrt{6 + 0{,}0742} \times (0{,}1497 - 0{,}051)$$
$$= 0{,}7\sqrt{6 + 0{,}0742} \times 0{,}098$$
$$= 0{,}7 \times 2{,}46 \times 0{,}098$$
$$= 0{,}168kg$$

The result of the shortage in tapioca flour units is 0.168 kg

e. Calculating total cost (OT)

The final step is to calculate the total cost. This total cost calculation is done using the following formula.

$$OT = D_P + \frac{A}{T} + h\left(R - D_L + \frac{D_T}{2}\right) + \frac{C_u}{T} N$$
$$= (12{,}12kg \times Rp.8.000) + (\frac{Rp.10.000}{6}) + (Rp.2.475 \times \left(76{,}02kg - (12{,}12kg \times 0{,}0742) + \left(\frac{12{,}12kg \times 6}{2}\right)\right) + \frac{Rp.200.000}{6} \times 0{,}168kg$$
$$= Rp.96.960 + Rp.1.666 + Rp.95.955 + Rp.5.599$$
$$= Rp.200.186$$

The result of the total cost calculation ($O_T = O_b + O_p + O_s + O_k$) of tapioca flour is Rp. 200,186.

f. Calculating the level of service (η)

In this step in calculating the service level, the formula is as follows.

$$\eta = 1 - \frac{N}{DL}$$
$$= 1 - \frac{0{,}168kg}{12{,}12kg \times 0{,}0742}$$
$$= 1 - \frac{0{,}168kg}{0{,}899kg}$$
$$= 1 - 0{,}186874$$
$$= 0{,}81 = 81\%$$

The results of the calculation of the level of service for tapioca flour are 81%.

3.3 Data Analysis

Data analysis is based on the results of the data processing above, and can be concluded as follows:

3.3.1 Data Normality Test

The results of the normality test using the Shapiro–Wilk method show that all demand data for four raw materials, namely beef, chicken, sago flour, and tapioca flour, meet the assumption of normal distribution. This is evidenced by a p-value greater than 0.100. In addition, the normality test also produces supporting information in the form of average values, standard deviations, and Ryan–Joiner test results which are presented in the following tables [17], [18], [19]:

Table 1
Recap of Data Normality Test Results

Types of Raw Materials	Mean	Std Dev	N	RJ	P-Value
Beef	84,81	5,443	24	0,993	>0,100
Chicken	36,35	2,333	24	0,993	>0,100
Sago Flour	24,23	1,555	24	0,993	>0,100
Tapioca Flour	12,12	0,7775	24	0,993	>0,100

Based on the results in Table 1, all raw materials have a Ryan–Joiner (RJ) value of 0.993, indicating a very high level of conformity to the normal distribution. An RJ value close to 1 indicates that the demand data pattern is relatively stable and does not experience many extreme fluctuations. This is supported by a p-value > 0.100, so there is no reason to reject the hypothesis that the data is normally distributed. In addition, the mean and standard deviation values for each raw material show different levels of variation. Beef and chicken have relatively higher standard deviations than sago flour and tapioca flour, which means that demand for both is more volatile. Meanwhile, sago flour and tapioca flour have smaller demand variations, making them easier to predict [20], [21]. This condition is important because the smaller the demand variability, the lower the need for safety stock and the simpler inventory control. Thus, the results of this normality test support the feasibility of using probabilistic methods in inventory calculations.

3.3.2 Probabilistic Calculation of P Back Order

Based on calculations using the probabilistic P Back Order method, the results show that the four main raw materials at UD XYZ, namely beef, chicken, sago flour, and tapioca flour, have ordering interval (T_o), maximum inventory (R), and total cost (OT) values. The following are the calculation results:

Table 2
Summary of Probabilistic Calculation Results for the P Back Order Model

Types of Raw Materials	To (Day)	Qo (Kg)	SS (Kg)	R (Kg)	OT
Beef	3	254,43	23,81	278,24	Rp. 9.705.474
Chicken	3	109,05	8,49	117,54	Rp. 1.481.784
Sago Flour	6	145,38	7,2	152,58	Rp. 946.617
Tapioca Flour	6	72,72	3,3	76,02	Rp. 200.186

The results in Table 2 show that the ordering interval (To) for beef and chicken is every 3 days, while sago flour and tapioca flour have an ordering interval of 6 days. This difference corresponds to the characteristics of each raw material, where beef and chicken have higher daily demand and greater demand variability, thus requiring more frequent ordering. The resulting Order Quantity (Qo) value reflects the optimal ordering requirements to maintain a balance between ordering costs, storage costs, and backorder risk. The raw material with the highest demand, namely beef, produces the highest Qo (254.43 kg), followed by sago flour and chicken. Meanwhile, tapioca flour has the smallest Qo (72.72 kg) along with the lowest daily demand. The Safety Stock (SS) and Reorder Point (R) values indicate that raw materials with the most fluctuating demand require higher safety reserves. For example, beef has the highest SS (23.81 kg) to anticipate demand uncertainty. Overall, total inventory costs (OT) are in line with raw material requirements, with beef generating the highest costs and tapioca flour the lowest.

This analysis shows that the probabilistic P Back Order method successfully provides efficient ordering recommendations that are in accordance with the demand characteristics of each raw material, so that it can help companies reduce inventory costs while maintaining service levels [22].

4. Conclusion

Based on the results of data analysis on the inventory control of frozen meatball raw materials at UD XYZ using the probabilistic P Model method with back orders, it can be concluded that this method is able to help companies determine efficient order quantities, determine the right ordering time, and reduce the risk of stockouts. The calculation results show that beef raw materials reach optimal conditions with an ordering interval of every 3 days, an order size of 278.24 kg, a total cost of Rp9,705,474, and a service level of 75%. For chicken meat, optimal orders are also made every 3 days with a quantity of 109.05 kg, a total cost of Rp1,481,784, and a service level of 80%. For sago flour raw materials, the best results are obtained with an ordering interval of every 6 days, an order size of 152.58 kg, a total cost of Rp946,617, and a service level of 76%. Meanwhile, tapioca flour has the same ordering interval, namely every 6 days with a quantity of 76.02 kg, a total cost of Rp200,186, and a service level of 81%. Overall, the application of the probabilistic P Model method has been proven to produce a more controlled and optimal inventory system for UD XYZ in meeting the production needs of frozen meatballs.

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