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Article

Risk Identification and Management Analysis at Company X Using FMEA and EPQ Methods

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Abstract

This study aims to identify and manage risks in Company X's instant noodle production process using Failure Mode and Effects Analysis (FMEA) and Economic Production Quantity (EPQ) methods. FMEA is used to analyze potential failure modes, while EPQ optimizes production quantities to minimize storage and overproduction costs. The research identifies key risks such as overproduction, machinery failures, and packaging defects. Data collected includes production volumes, raw material usage, and defect rates. FMEA reveals that overproduction is the primary risk, leading to high storage costs. EPQ calculations are performed to determine the optimal monthly production for three instant noodle variants, resulting in significant cost savings. The study concludes that implementing EPQ alongside FMEA minimizes risks and reduces inventory management costs, highlighting the importance of systematic risk management in production optimization. This approach helps Company X enhance efficiency while cutting purchasing and costs expenses by Rp. 3,900,000.00 per month.

Keywords: Cost Optimization, EPQ, FMEA, Overproduction, Risk Management

1. Introduction

Humans cannot separate themselves from the need for food in daily life. From morning to night, everyone requires food to be converted into energy to carry out daily activities. The types of food consumed vary, from carbohydrate sources like rice, bread, potatoes, and tubers to proteins like chicken, eggs, fish, and vegetables. Additionally, various processed foods, such as instant noodles, milk, snacks, and flour-based products, are also frequently consumed by the Indonesian population.

The food industry is an economic sector that includes the production, management, distribution, and sale of food to consumers. This industry is vast, involving various types of businesses, from agriculture and livestock as raw material producers to the processing, packaging, distribution, and sale of ready-to-eat food products. The importance of this industry lies in fulfilling the basic human need for healthy and nutritious food [1][2]. Activities within the food industry range from small- to large-scale enterprises across various levels of food production [3]. The industry continues to grow alongside changes in consumer trends, technological innovations, and government regulations on food safety and health. Sustainability, efficiency, product quality, and adherence to food safety standards are priorities in the food industry [4].

Company X is a Total Food Solutions company that handles all stages of food production, from raw material processing to the final product ready for sale. Company X is known

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as an established company operating across various business categories. Its advantages stem from economies of scale and the strength of its business model, which consists of several business units. However, there are certain risks in its production processes, such as product defects in color and packaging. Other risks involve machinery that may encounter issues and need to be temporarily halted.

Given these issues, a risk analysis is needed to address the problem of overproduction, which leads to high storage costs. The analysis will be conducted using the FMEA and EPQ methods to determine the optimal production quantity. FMEA is a systematic method used to identify, analyze, and mitigate the risks of failure in a process, product, or system [5]. With FMEA, each potential failure in a process or product is analyzed based on its impact, cause, and likelihood of occurrence, allowing preventive or corrective actions to be identified and implemented to minimize risks [6]. EPQ (Economic Production Quantity) is a production management method used to determine the optimal production quantity in a single cycle to minimize total costs [7]. This method is an extension of EOQ (Economic Order Quantity), commonly used in inventory management. EPQ considers that production is carried out gradually, so the quantity of goods increases over time. EPQ is highly useful in situations where production and demand occur simultaneously and has the primary goal of optimizing production quantities while considering various related costs [8].

2. Material and Method

This research began with field studies aimed at understanding the actual situation within the company and identifying the research objectives to be achieved. After conducting direct observations and discussions with relevant parties, several issues that need to be resolved were identified. Based on these issues, the next step was to gather relevant data to support the analysis.

The data used in this study includes instant noodle production data over a one-month period, which covers the number of units produced and the production frequency. In addition, data on defects in instant noodle packaging was collected over the same period to assess product quality levels. Raw material data for instant noodle production, such as flour, spices, and packaging materials, was also recorded to understand the needs and associated costs. Along with raw material data, the study also includes data on the cost of ordering raw materials, which is the cost incurred by the company each time it orders materials from suppliers, as well as data on the cost of finished product storage, which covers operational costs for storing and maintaining products in the warehouse.

After collecting these data, data was processed using two analytical methods: Failure Mode and Effects Analysis (FMEA) and Economic Production Quantity (EPQ). FMEA analysis was conducted to identify the biggest risks faced by the company. In this case, the largest risk found was overstock or excess inventory in instant noodle production, which directly impacts the increased storage costs in the warehouse. The high inventory level causes the company to incur additional costs for storage, maintenance, and management of stock that is not immediately sold.

Once the overstock risk was identified through FMEA, the study proceeded to the EPQ calculation stage. The EPQ method aims to calculate the optimal production quantity that should be carried out in the following month to minimize storage and production costs. The data used in the EPQ calculation is derived from the previous month's production data, reflecting the actual needs and production capabilities of the company. By using EPQ, it is expected that the company can set an optimal production amount each month, thereby minimizing overstock risks and high storage costs sustainably.

3. Results and Discussion

3.1. Risk Identification and Corrective Measures

3.1.1. Risk Type

Financial Risks include have not made detailed financial reports with improvement efforts are make financial reports transparently and include all aspects of the production process from purchasing raw materials to shipping.

Raw material price fluctuations with improvement efforts are find several suppliers of raw materials for making instant noodles. Supply demand does

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not match, resulting in over-storage costs with improvement efforts are calculate the best production using last month's purchase data.

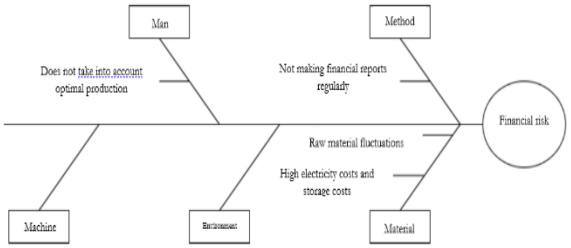

Fig. 1. Fishbone Diagram of Financial Risks.

Operational Risks include decrease in sales with improvement efforts are create new strategies and promote products can be seen in Fig.1. Some machines are not running due to lack of regular maintenance with improvement efforts are pay attention to machine maintenance and record old machines and then perform periodic service. Lack of implementation of workers' SOPs with improvement efforts are provide appeals and sanctions if you violate the SOP too often.

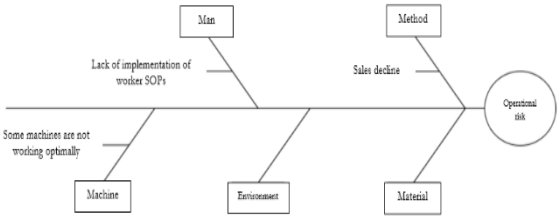

Fig. 2. Fishbone Diagram of Operational Risks.

Product Risks include defects of some raw materials with improvement efforts are checking raw materials when they first come to the warehouse and sorting them can be seen in Fig.2. The quality produced is not the same with improvement efforts are minimize errors in work starting from further tightening the selection of raw materials. Plastic/ Packaging packaging defects with improvement efforts are improve communication to minimize defects during production can be seen in Fig.3.

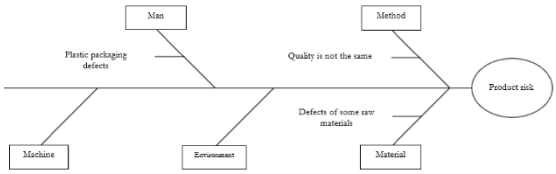

Fig. 3. Fishbone Diagram of Product Risks.

3.2. Raw Material, Production and Defect Data

Table 1 displays raw material data, quantity and defect for one month

Table 1. Month Raw Material and Defect Data.

No	Raw Materials	Quantity(Unit)	Defect
1	Wheat Flour	1000 kg	5 kg
2	Oil	600 pcs	50 pcs
3	Salt	300 pcs	10 pcs
4	Flavor Enhancers	200 liter	5 liter
5	Food Dyes	500 pcs	8 pcs
6	Thickener	200 bottles	15 bottles
7	Additional Ingredients	300 liter	20 liter
8	Packaging	10.000 pcs	150 pcs

Table 2. Month Production Data.

No	Raw Materials	Total Production	Sold	Remaining
1	Fried Instant Noodles	3.700 pcs	1.430 pcs	2.270 pcs
2	Soto Kuah Instant Noodles	3.350 pcs	1.390 pcs	1.960 pcs
3	Soto Kari Instant Noodles	2.950 pcs	1.300 pcs	1.650 pcs

Table 2 displays raw material data, total production, sold and remaining for one month. In this research, month raw material data and month production and defect data can be seen in Table 1 and Table 2. With selling price Fried Instant Noodles Rp3.200,00/pcs, Soto Kuah Instant Noodles Rp3.100,00/pcs and Soto Kari Instant Noodles Rp3.100,00/pcs.

3.3. Related Costs

3.3.1. Raw Material Ordering Cost

Ordering Costs that includes Telephone Costs Rp350.000,00/month, Gasoline Cost

(Transportation) Rp1.250.000,00/month with total Rp1.600,000/month.
In this study, there are several limitations, one of which does not display the cost of raw materials which is confidential company data.

3.3.2. Storage Cost

Storage Costs that includes Lead Time 2 days, Electricity Cost Rp3.500.000,00/month, Water Cost Rp1.200.000,00/month, Other Expenses Rp1.000.000,00/month with total Rp 5.700.000,00/month.

The costs listed are data sourced directly from the company and the details of the data are confidential company data.

3.4. Solution Method

3.4.1. FMEA Analysis

In this research, solution method can be seen in Table 3, Table 4, Table 5 and Table 6. SOD Assessment Parameters which include Severity of Effects (Severity) with level 1 (very low), 2 (low), 3 (normal), 4 (high), 5 (dangerous). Occurrence Frequency with level 1 (very low), 2 (low), 3 (normal), 4 (high), 5 (dangerous). Cause Detection with level 1 (very low), 2 (low), 3 (normal), 4 (high), 5 (dangerous).

Then manual calculations are carried out using the following formula:

RPN = S x O x D (1)

Table 3. FMEA Analysis of Noodle Business.

defect type	S	O	D	RPN	Rating
Raw material damaged	3	3	4	36	II
Some raw material packaging leaked	3	3	2	18	III
Overproduction	4	3	4	48	I

The biggest risk is overproduction, which causes high storage costs. Therefore, an EPQ calculation is carried out to determine the optimal production that should be done.

3.4.2. EPQ Method

Then manual calculations are carried out using the following formula :

$$EPQ\ (Q) = \sqrt{\frac{2(U)(S)}{(1-U/P)C}} \quad (2)$$

with :
Q = Economic Production Quantity
U = Demand per period
P = Production per period
S = Setup cost
C = Monthly storage cost per unit 3700, 3350, 2950

So the results of the EPQ Fried Instant Noodles equation are obtained as follows:

$$EPQ\ (Q) = \sqrt{\frac{2(3700)(1.600.000)}{\left(1-\frac{3700}{1.600.000}\right)5.700.000}}$$

$$= \sqrt{\frac{11.840.000.000}{5.686.818,75}}$$

= 45,6 = 46/production times
= 46 x 30 = 1380 pcs/month

The results of the EPQ Soto Kuah Instant Noodles equation are obtained as follows:

$$EPQ\ (Q) = \sqrt{\frac{2(3350)(1.600.000)}{\left(1-\frac{3350}{1.600.000}\right)5.700.000}}$$

$$= \sqrt{\frac{10.720.000.000}{5.686.065,625}}$$

= 43,4 = 44/production times
= 44 x 30 = 1320 pcs/month

The results of the EPQ Soto Kari Instant Noodles equation are obtained as follows:

$$EPQ\ (Q) = \sqrt{\frac{2(2950)(1.600.000)}{\left(1-\frac{2950}{1.600.000}\right)5.700.000}}$$

$$= \sqrt{\frac{9.440.000.000}{5.689.490,625}}$$

= 40,7 = 41/production times
= 41 x 30 = 1230 pcs/month

3.5. Comparison of Initial Production with After EPQ Calculation

Table 4. Comparison of Initial Production and After EPQ Calculation.

No	Instant Noodles	Before EPQ Calculation	After EPQ Calculation

1	Fried Instant Noodles	3.700 pcs	1.380 pcs
2	Soto Kuah Instant Noodles	3.350 pcs	1.320 pcs
3	Soto Kari Instant Noodles	2.950 pcs	1.230 pcs

Table 5. Comparison of Initial Sales and Production After EPQ Calculation.

No	Instant Noodles	Before EPQ Calculation	After EPQ Calculation	Remaining
1	Fried Instant Noodles	1.430 pcs	1.380 pcs	50 pcs
2	Soto Kuah Instant Noodles	1.390 pcs	1.320 pcs	70 pcs
3	Soto Kari Instant Noodles	1.300 pcs	1.230 pcs	70 pcs

Table 6. Comparison of Ordering and Storing Costs for 1 Month.

No	Cost Type	Before EPQ Calculation	After EPQ Calculation	Savings
1	Purchase Cost	Rp1.600.000,00	Rp900.000,00	Rp700.000,00
2	Storage Cost	Rp5.700.000,00	Rp2.500.000,00	Rp3.200.000,00

4. Conclusions

Based on the results of the analysis carried out, it was concluded that the risks that exist in Company X including financial, operational and product risks with each of which there are risks and fishbone analysis. The biggest risk chosen in this Big Task is over production, causing large storage costs and raw material purchase costs for the company. To solve the risk in number 1, the optimal production calculation is carried out using the EPQ method which results in the optimal production of fried instant noodles is 1,430 pcs / month, instant soup noodles is 1,390 pcs / month and instant curry soup noodles is 1,300 pcs / month. Where each still has the remaining production of 50, 70 and 70 pcs respectively, which minimizes or reduces purchasing costs and storage costs by Rp. 3,900,000.00.

References

[1] A. Gamage *et al.*, "Role of Organic Farming for Achieving Sustainability in Agriculture," *Farming System*, vol. 1, no. 1, Apr. 2023.

[2] N. R. Wani, R. A. Rather, A. Farooq, S. A. Padder, and T. R. Baba, "New Insights In Food Security And Environmental Sustainability Through Waste Food Management," *Environmental Science and Pollution Research*, vol. 31, pp. 17835–17857, Mar. 2024.

[3] Y. Jararweh, S. Fatima, M. Jarrah, and S. AlZu'bi, "Smart And Sustainable Agriculture: Fundamentals, Enabling Technologies, And Future Directions," *Computers and Electrical Engineering*, vol. 110, no. 108799, Sep. 2023.

[4] C. O. Okpala and M. Korzeniowska, "Understanding the Relevance of Quality Management in Agro-food Product Industry: From Ethical Considerations to Assuring Food Hygiene Quality Safety Standards and Its Associated Processes," *Food Reviews International*, vol. 39, no. 4, pp. 1879–1952, 2023.

[5] S. Peddi, K. Lanka, and P. Gopal, "Modified FMEA Using Machine Learning For Food Supply Chain," in *Materials Today: Proceedings*, S. Peddi, K. Lanka, and P. Gopal, Eds., Materials Today: Proceedings, 2023.

[6] B. Salah, M. Alnahhal, and M. Ali, "Risk Prioritization using a Modified FMEA Analysis in Industry 4.0.," *Journal of Engineering Research*, vol. 11, no. 4, pp. 460–468, Dec. 2023.

[7] M. Y. Jaber and J. Peltokorpi, "Economic Order/Production (EOQ/EPQ) Quantity Models With Product Recovery: A Review Of Mathematical Modelling (1967-2022)," *Appl Math Model*, vol. 129, pp. 655–672, May 2024.

[8] A. Taleizadeh, M. S. Naghavi-Alhoseiny, L. E. Cárdenas-Barrón, and A. Amjadian, "Optimization Of Price, Lot Size And Backordered Level In An EPQ Inventory Model With Rework Process," *RAIRO-Operations Research*, vol. 58, no. 1, pp. 803–819, Feb. 2024.