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Development of an Excel Dashboard-Based Warehousing Administration System Using the Design Thinking, EOQ, and POQ Approaches

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ABSTRACT

Warehousing is an important part of a manufacturing process where ideal warehouse management will improve the company's logistics in times of crisis. This research seeks to gain an in-depth understanding of the problems faced by warehousing and create user-focused solutions. Furthermore, EOQ and POQ methods are used to optimize stock and order management. EOQ helps determine the economical number of bookings to be made, while POQ considers demand variability in determining order schedules. The results of this study show that with Design Thinking, it was found that the needs of users are the use of an easier application system and stock filling standards so that the accuracy of stock is better maintained. It can be concluded that the EOQ and POQ methods can overcome understock and overstock. However, the EOQ method has less risk than POQ, this is because the company does not spend a lot of funds and takes with little frequency so it is more effective and the warehouse movement space can be more minimal.

Introduction

The strategy for increasing the company's profits is to develop business processes and sales. According to TOPP, a business process is a logically related chain of repetitive activities that uses company resources to process an object (physical or mental) to achieve a product or result that has been measured and determined for internal and external customers (Singh et al., 2019).

Many companies face challenges in developing these business processes, including in managing inventory, such as high inventory costs, the risk of inventory shortages, and operational complexity. Therefore, innovative solutions are needed to overcome these problems. According to (Rushton et al., 2022), warehouses require expensive costs by making 2-5 percent of a company's sales costs. Ideal warehouse management will improve the company's logistics in times of crisis. Warehouse monitoring is such as sufficient inventory of goods with the right arrival time and minimal inventory costs, how effective

and efficient employees are in working, the use of technology in the warehousing system, the use of warehouse area, and the quality of goods in the warehouse (Jae, 2024).

In manufacturing companies, the problem that often occurs is the occurrence of poor control of the stock in the warehouse, both raw material warehouses and finished warehouses. Organizations or manufacturing companies store inventory including raw materials, supplies used for production, and finished goods (Samsudin et al., 2023).

PT. XYZ is a manufacturing company where manufacturing is a company that processes raw materials into a finished product (finished goods) with process stages including, product design, material selection, and process stages (Amri et al., 2023). PT. XYZ is a company engaged in textiles that are integrated from cotton to yarn, yarn to raw fabric, raw fabric to color fabric, and color fabric into apparel. At all times, production and delivery activities are carried out to increase customer satisfaction and commitment. At PT. XYZ inventory control process at PT. XYZ such as recording production realization, stock inventory management, recording of outgoing goods, and recording of incoming and outgoing goods are still done manually by recording in books (Fujiati, 2023). This takes a long time because the data that is worked on often experiences human error due to manual processing. This system also has other problems, namely it takes a long time to work, less effective and efficient (Dewi et al., 2022).

This study aims to discuss the improvement of warehousing administration through the design of an Excel-based stock system with the Design Thinking, Economic Order Quantity (EOQ), and Periodic Order Quantity (POQ) approaches. Where this system is expected to be a strategy that aims to increase efficiency and effectiveness in managing inventory in the warehouse and is included in the product development business process.

Method

In identifying problems, field studies and literature studies are carried out. The field study was carried out by taking and seeing the real situation of the problem in the warehouse of PT. XYZ. In the initial stage, interviews will be conducted with the warehouse admin and warehouse staff related to the inventory system in the warehouse. Through the interview, problems in the warehouse will be found regarding the inventory system that is still not optimal (Kuantitatif, 2016).

In the literature study conducted in this study by studying theories related to problems in the field that will be solved in this study, including theories about production, planning, and control supply chain management. The theory will later be used as a guideline in solving existing problems.

Data Collection Techniques

At this stage, several things must be done, including the following:

a. Observation

Observation is carried out by observing ongoing activities and data that is treated to meet the needs of the system to be created. Then observations were made by finding several problems, including the processing of the inventory system. The observation carried out is

the administrative process that has been happening in the PT.Xyz warehouse starts from the process of receiving, controlling stock, and issuing finished goods.

b. Interview

Interviews are activities that are carried out by gathering the information and data needed to build a system. This interview is conducted by conducting face-to-face interviews with people who are experts in the field to be researched. Then the results of the interviews that have been conducted can be used as a reference to develop a practical, efficient, and good system. The interviews conducted were qualitative and quantitative. Interviews will be conducted with related parties, namely the admin and warehouse supervisor.

c. Questionnaire

According to (Sugiyono, 2017), a questionnaire is a data collection activity or technique carried out by giving a set of questions or written statements to respondents to answer. This questionnaire contains satisfaction regarding the administration of the warehouse that has been running in the warehouse and will be given to the admin as a person who is responsible for directly carrying out administration in the warehouse.

Warehousing Administration System Architectural Design

A good warehousing administration system architectural design must consider several important aspects to ensure operational efficiency and effectiveness. Here are some of the main elements as follows:

1. Organizational Structure

In the organizational structure, it is necessary to determine the hierarchy and responsibilities of the warehousing team such as warehouse staff, administrative teams, and operators in the field.

2. Inventory Management

Inventory Management here is used to search for stock, stock status, condition of goods, and other related information.

3. Operational Process

Develop procedures or SOPs for the receipt, storage, retrieval, and receipt of goods.

4. Information Technology

The use of software to support warehousing management in automating and updating data in real-time.

5. Warehouse Layout

Design a warehouse layout that can maximize the use of space and facilitate access to goods.

6. Equipment

Selection of the right equipment such as forklifts, pallets, and other auxiliary tools to increase productivity.

Results and Discussion

PT. XYZ is a company engaged in the textile and garment sector that was established in 1974. Currently, PT. XYZ has 3000 employees and has a wide range of units. However, this study will focus on one of the warehouses in the PT. XYZ. The finished warehouse at PT. XYZ is a warehouse that can accommodate goods with a maximum capacity of up to 10 million meters. This warehouse serves sales or marketing requests to unload goods and PPIC parts to inform the number of available stock (Apriyani, 2020). In the organizational structure, the warehouse greige has several staff and employees who are responsible for the process of activities in the warehouse. The number of personnel in the finished warehouse is 2 admins and 6 operators. The following is the organizational structure in the finished warehouse of PT. XYZ:

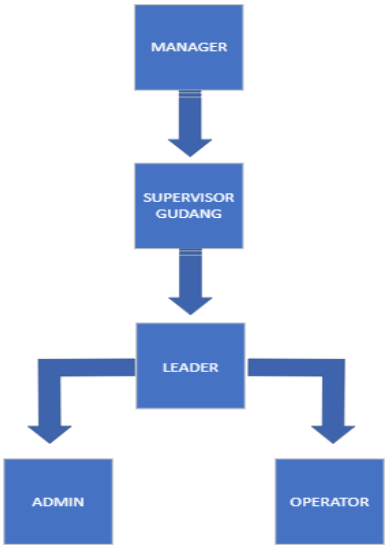

Chart 1
Organizational Hierarchy in Warehouses

The picture above is the arrangement of the organizational structure in the warehouse of PT. XYZ. The duties of each are as follows:

a. Manager, as the highest leader of one of the units in PT. XYZ has a strategic role in determining the policy and direction of the unit by the goals of top management. In addition, managers must ensure that production targets are by the goals that have been set.
b. Warehouse supervisor, as the head of the warehouse in one of the units at PT. XYZ has the responsibility of managing the processes that occur in the field and administration in the warehouse. The warehouse also has the responsibility of serving marketing, PPIC, and internal buyer requests.

c. Warehouse leaders, have a responsibility to ensure that processes in the warehouse, especially processes in the field, run smoothly. The leader is also responsible for managing operators and admins in the warehouse.
d. Warehouse admins, have the responsibility of taking care of administrative processes in the warehouse. In addition, the admin is in charge of completing the mutation documents that occur in the warehouse.
e. Warehouse operators, have responsibilities in field activities starting from product preparation and product delivery to buyers.

Emphasize

The emphasize stage is carried out by the researcher to make observations to understand the condition of the user. This observation was carried out to obtain data according to the problems faced by the warehouse team of PT. XYZ. The research is carried out as follows:

a. Survey the warehouse admin team involved in warehouse activities to gain an understanding of the situation that occurs in the warehouse related to the administration that has been carried out in the warehouse so far.
b. In-depth interviews with warehouse supervisors and PPIC related to stock supervision, production planning, and delivery of goods.
c. Interview with sales regarding the method of selling finished goods and passive stock goods.

Questionnaire Survey Results

At this stage, the author shared a questionnaire involving PPIC, admins, and warehouse supervisors in giving their responses regarding the use of the administration system application that is currently running (Fujiati, 2023). The purpose of this questionnaire is to give the author an overview of the elements that are prioritized for the development of the administrative system in the warehouse.

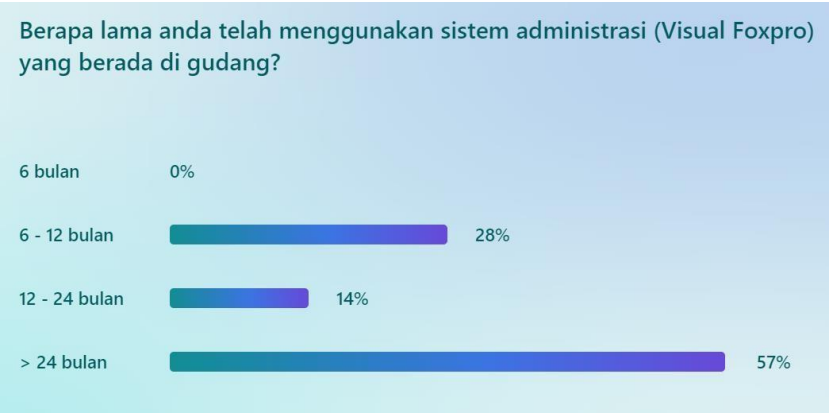

Figure 2
Results of the Foxpro Usage Duration Questionnaire

In the results of the questionnaire above, it can be seen that 50% of respondents have used the current warehouse administration system for more than 24 months or 2 years, then

as many as 25% have used this system within 6-12 months and another 25% have used this system in the range of 12-24 months. Then the author distributed a questionnaire related to user satisfaction with using the Foxpro visual administration system and the results obtained were as follows:

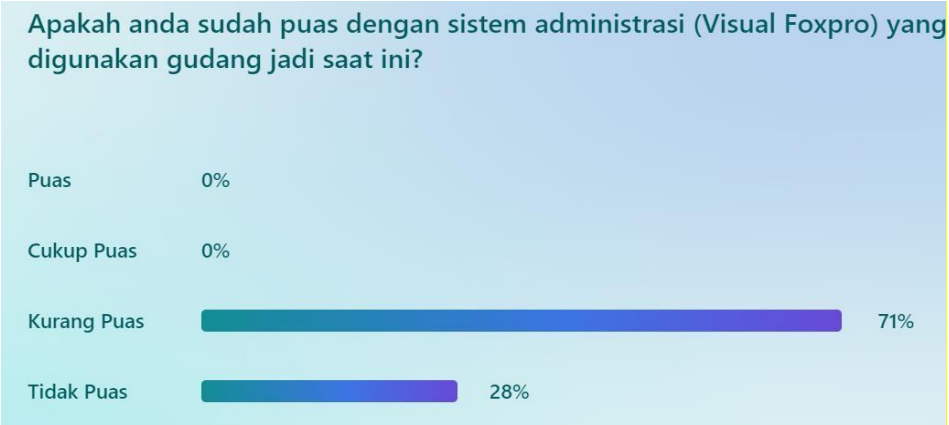

Figure 3 Satisfaction Level with the Old Stock System

Satisfied with the administrative system used now. Furthermore, the researcher shared a questionnaire related to the difficulties faced by users when using the application. This is proven by the lead time required for the application to present data is 20 minutes. The answer obtained is as follows:

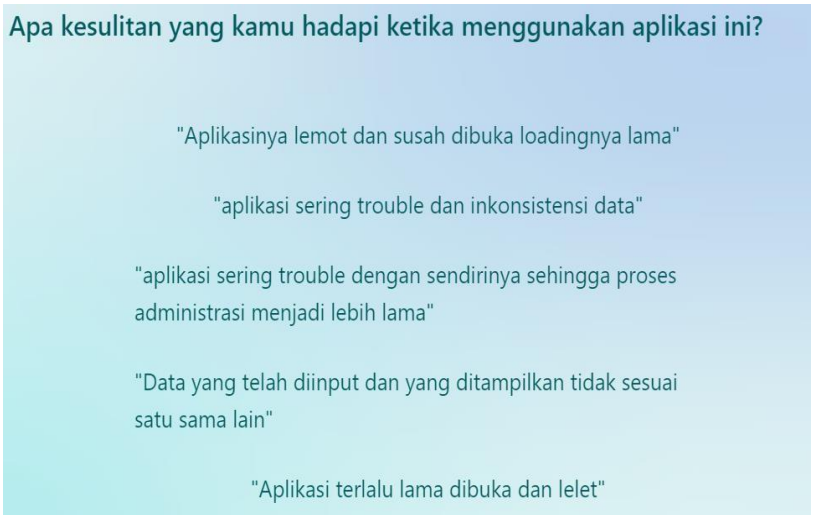

Figure 5
Respondents' Results Regarding the Difficulties Faced Using Foxpro

From the results above, it can be seen that the majority of users complain about the application of the administration system used still often experiencing problems and inconsistencies in the data input and displayed.

Testing Stages

At this stage, the researcher will carry out the testing stage using UAT (User Acceptance Test) so that the offered solution runs effectively and efficiently. The test results of each feature can be seen in the table below:

Table 1
Testing on Sheet in Item

No	Functionality	Comment	Status
1	Construction columns can be automated appears after Master code input	Column size to be enlarged so that data is easily input	Done
2	Filter button Data search may appear		Done
3	Stock automatically increases when entering data		Done

In the table above, the test related to the sheet in item on the dashboard stock balance in the warehouse went smoothly. This sheet function can run well and the results are satisfactory. The input from the user is to make the column larger so that it is easier for users to see.

Table 2
Pengujian pada Sheet Out Item

No	*Functionality*	*Comment*	Status
1	Nominal price items can appears according to the number of items that di input		Done
2	Filter button Data search may appear		Done

3	Automatic reduction input is made Data in *this* sheet	stock when	Done

In the test table for sheet items 3 tests are mandatory and important features in this sheet, the feature is expected to run normally and users can have no difficulty using it.

Use of EOQ

EOQ (Economic Order Quantity) has never been applied in PT. XYZ in controlling inventory. So sometimes there is often a shortage and excess stock of goods. So this EOQ method is needed to determine accurate calculations. The implementation of the use of the EOQ method can be obtained at the appropriate time and synchronously without making inventory that exceeds the limit, which means that it can reduce the expenditure that appears in the inventory (Andira, 2016).

The EOQ calculation in this study will use data from the last 1 year, namely 2023. Where out of 350 types of goods listed, the author takes 3 types of goods with high receipts and expenditures in 2023. These three types of goods are raw materials that are often ordered for the fulfillment of the next process, namely the fabric dyeing process. In short, the process that occurs is when the process of sending raw fabrics to the warehouse of PT. XYZ is completed, later this fabric will be sent to the next unit from PT. XYZ is the dyeing process. Where the fabric dyeing unit will dye the fabric before it will later be processed in the convection unit or garment into a garment. This study will calculate data in the last year, namely 2023, which is shown in the table below. PPIC in the fabric dyeing process unit will coordinate with sales who already have a sales contract then PPIC will make a schedule for the fabric dyeing process and take the fabric from the warehouse through the fabric booking code and each process will be given an SP code (production letter).

The following is a table of raw material fabric requirements from dyeing PPIC needed in 2023.

Table 2
CD Material Requirements 1206063/ Master Code 82

Moon	Inventory (meters)	Requirement (meters)
January	542.486,00	43.000,00
February	511.242,00	195.281,00
March	449.036,50	111.341,00
April	380.901,00	141.499,00
May	344.014,50	3.850,00
June	10.897,00	632.090,00
July	322.125,50	456.874,00

August	177.505,50	41.134,50
September	461.457,50	45.762,00
October	365.619,50	63.769,00
November	275.739,50	43.244,00
December	7.482,50	29.309,00
Total		1.807.153,50

Table 3
PC Material Requirements 1337263 / Master Code 101

Moon	Inventory (meters)	Requirement (meters)
January	332.211,00	118.310,00
February	133.670,00	250.183,50
March	22.185,50	327.518,50
April	10.239,50	15.000,00
May	252.602,50	19.500,00
June	291.512,00	57.000,00
July	199.040,00	88.057,00
August	28.541,00	303.260,00
September	79.566,50	54.504,00
October	31.109,00	341.986,00
November	89.555,50	39.002,00
December	125.540,00	25.000,00
Total		1.639.321,00

Table 4
CD 887047 Material Requirements / Master Code 134

Moon	Inventory (meters)	Requirement (meters)
January	48.235,50	545.103,00
February	274.159,00	31.460,00
March	322.335,00	5.000,00
April	378.424,50	129.630,00
May	443.434,50	24.000,00

June	556.123,00	135.000,00
July	391.430,00	25.000,00
August	118.409,00	1.509,00
September	79.621,50	21.058,00
October	64.484,00	15.088,00
November	64.325,00	-
December	25.669,50	202.668,00
Total		1.135.516,00

Based on the data above, the average cost of using these raw materials can be calculated. The formula used is as follows:

$$X\,rata - rata = \frac{\text{Number of Raw Material Needs}}{Frekuensi\ Pemesanan\ Bahan\ Baku}$$

The frequency of ordering raw materials is carried out 150 times a year, meaning that orders are made 3 times a week. So the calculation is as follows:

1. Average requirements of raw materials master code 82

$$Xrata - rata = \frac{1.807.153,5}{150} = 12.047,69$$

2. Average requirements for master code raw materials 101

$$Xrata - rata = \frac{1.639.321}{150} = 10.928,81$$

3. Average requirements for raw materials of master code 134

$$Xrata - rata = \frac{1.135.516}{150} = 7570,11$$

Safety Stock

For the use of raw materials and on average, the Safety Stock model will be used. The formula used is as follows:

$SS = Safety\ Stock = \sigma\ X\ Z$

Where the author will use a service level of 95% so that with the distribution table the Z value is obtained below the normal curve of 95%, which is 1.65.

a. Safety Stock for the use of raw materials master code 82.
   SS = (195.196,95 *1,65) = 322.075 metre
b. Safety Stock for the use of raw materials master code 101.
   SS = (129.879,6 * 1,65) = 214.301 metre

c. Safety Stock for the use of raw materials master code 134. SS = (156.286.43 * 1.65) = 257.873 meters

Comparative Analysis of Inventory Control

From the results of the calculations and analysis that have been carried out, the company PT. XYZ will be able to find out the right and most optimal method to be applied. The table below is the company's policy in ordering raw materials in 2023.

Table 5
Data Kebijakan Perusahaan Tahun 2023

No.	Policy Company	Year Request 2023
1	Stock Request Thing	12,048 meters
2	Booking Fee	IDR 300,000
3	Inventory Costs	IDR 26,278,500

Raw Material Inventory Analysis Master Code 82

Using the EOQ and POQ methods, we can compare the data used by the company to calculate the raw material requirements of master code 82 by taking into account EOQ, and the POQ calculation in the data below:

Table 6
Comparison of Corporate Policy Methods with EOQ and POQ in Ordering Raw Materials Master Code 82

No.	Information	Policy Company	EOQ	POQ
1	Stock Request Average Goods	12,048 meters	273,068 meters	75,298 meters
2	Total Cost	IDR 41,276,011.00	IDR 3,970,781	IDR 10,162,832
3	Frequency Most recent booking	150	7	24

In the data above, we can see before using the EOQ and POQ methods, PT. XYZ carries out its policy by requesting stock of master code 82 goods with an average of 12,048 meters per order for 150 orders in a year with an accumulated cost of Rp 41,276,011.00. When compared to using the EOQ (Economic Order Quantity) method, PT. XYZ has made a saving of Rp 37,305,230.00 by minimizing the frequency of retrieval to 7 times. Meanwhile, by using the POQ (Periodical Order Quantity) method, it can save an inventory of Rp 22,113,179.00.

Inventory Analysis of Master Code 101 Materials

Table 7
Comparison of Corporate Policy Methods with EOQ and POQ on Master Code 101 Raw Material Orders

No.	Information	Policy Company	EOQ	POQ
1	Average Demand-Average Stock of Goods	10,929 meters	247.708 meters	68.305 meters
2	Total *Cost*	IDR 41,278,316	IDR 3,970,781	IDR 6,454,312
3	Frequency Most recent booking	150	7	24

In the table above, you can see the data and calculations to calculate the raw materials for master code 101, the company PT. XYZ requests an average of 10,929 meters per order with an order frequency of 150 times and a total cost of IDR 41,278,316. Meanwhile, by using the EOQ (Economic Order Quantity) method, there is a demand for a stock of goods with an average picking of 247,708 meters and a picking frequency of 7 times so if using EOQ, the company will save costs of IDR 37,305,230.00. Meanwhile, for calculations using the POQ method, it can save as much as IDR 31,113,179.00 by minimizing 24 takes.

Inventory Analysis of Master Code 134 Materials

Table 8
Comparison of Corporate Policy Methods with EOQ and POQ on Master Code 134 Raw Material Orders

No.	Information	Policy Company	EOQ	POQ
1	Average Demand-Average Stock of Goods	7,570 meters	171.581 meters	31,542 meters
2	Total *Cost*	IDR 41,278,500	IDR 1,998,626	IDR 13,703,453
3	Frequency Most recent booking	150	7	36

In the table above, you can see the data and calculations to calculate the raw materials of the master code 134, the company PT. XYZ requests an average of 7570 meters per order with an order frequency of 150 times and a total cost of IDR 41,278,500. Meanwhile, by using the EOQ (Economic Order Quantity) method, it is obtained that the demand for the stock of goods with an average of 171.58 meters and a frequency of picking is 7 times

so if using EOQ, the company will save costs of IDR 39,279,973.00. Meanwhile, for calculations using the POQ method, it can save as much as IDR 27,575,146.00 by minimizing 36 takes.

Excel Dashboard Stock Integration with EOQ

After looking at the comparison between the use of the company's system that has been running, the EOQ system, and the POQ, the author will integrate with the safety stock and ROP systems that have been sought before. So the results can be seen as shown in the picture below:

KODE MASTER	KONSTRUKSI	SALDO AWAL	IN	OUT	STOCK	RATA-RATA PERMINTAAN (EOQ)	SAFETY STOCK	ROP	STATUS
82	CD 120 60 63	232187,5	-	-	45.382,00	273.068	322.075	334.123	Pesan
101	PC 133 72 63	35305	-	-	156.134,00	247.708	214.301	225.230	Pesan
134	CD 88 70 47	8247	-	-	270.798,00	171581	257.873	265.443	Aman
			-	-	-				
		275.739,50	-	-	472.314,00				

Figure 6
Stock System Integrated with EOQ and POQ Methods

In the image above, it can be seen that the stock system will read the needs of production. If the stock data has a value smaller than ROP (Reorder Point), then the status column will turn red and show an "Order" status which means the warehouse must restock at least according to the EOQ amount and if the stock is larger than ROP it will appear a "Safe" status.

Conclusion

The conclusion of this study shows that by using the principles of Design Thinking, companies can design a more efficient and accessible system for inventory management. Some of the main needs identified by users are the creation of Key Products to facilitate the identification of goods, a warehouse administration system that can be accessed from anywhere and is easy to customize, real-time data displays, user-friendly input/output forms, and more detailed stock displays. In its implementation, the EOQ and POQ methods are compared to the methods used by the previous company, which placed orders 150 times a year. After the implementation of EOQ, the frequency of orders was drastically reduced to only 7 times a year for certain raw materials. Significant savings occurred, especially for items with master codes 82, 101, and 134, with the EOQ method resulting in greater savings than POQ. In conclusion, the EOQ and POQ methods are effective in avoiding understock and overstock, but EOQ is considered more efficient and has less risk. This data is then integrated into a new stock system compiled with Design Thinking principles, including ROP and Safety Stock, EOQ, and POQ to ensure optimal inventory management.

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