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QUALITY ANALYSIS OF REVERSE LOGISTICS DISTRIBUTION AT EXPIRED DRUG WAREHOUSE USING SIX SIGMA METHOD

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Abstract: PT. XYZ is one of the distributors of drugs and medical equipment, other than distribution, it also processes expired drug claims. The purpose of the drug claim is to exchange drugs with near expiry dates to become drugs with far expired dates so drug can be resold safely. And a reverse logistic method can be applied as an implementation process in expired drug claims. From the reverse logistics process, it doesn't always run well, causing the accumulation of drugs in the claim process to approach expired and dead stock in the warehouse for expired drugs at PT. XYZ. This research aims to determine the quality of the reverse logistics distribution of expired drug claims using the six sigma method. Data collection for this research was obtained by field research, literature study and interviews. Then the data is processed using Pareto diagram analysis tools, calculation of process capability, sigma capability, fishbone diagram, 5W+1H analysis and Standard Operational Procedure (SOP). The results of this research based on the fishbone diagram found that the factors causing the buildups were expired drugs which claim process was rejected by the principal, with sigma value = 1.4 and process capability value Cp = 0.50. These results show the value of process capability is low or not good, it is hoped that this research can help companies to improve their process capabilities.

Keywords: *Drug Distribution, Drug Expired Claims, Process Capability, Reverse Logistic, Six Sigma*

Introduction (Include Literature Review)

In 2020 there was an outbreak of the disease caused by the Covid-19 virus. Covid-19 is an infectious disease virus caused by the SARS-CoV-2 corona virus. This virus first appeared in December 2019 in the city of Wuhan, and has infected almost all countries in the world, including Indonesia, Since the outbreak of the corona virus (covid-19) pandemic. The demand for medicines and medical devices has also increased following the number of requests requested by hospitals, pharmacies and other health

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facilities. The following is the cumulative growth data of the Chemical, Pharmaceutical and Traditional Medicine Industries in the last 5 years.

Table 1. Growth Data for Chemical, Pharmaceutical and Traditional Medicine Industries

Growth in the Chemical, Pharmaceutical and Traditional Medicine Industry	
Years	Growth (%)
2021	9,61
2020	9,39
2019	8,48
2018	-1,42
2017	4,53

Source: (Statistics Indonesia, 2022)

For pharmaceutical wholesalers, drugs that are nearing expired can be claimed to the manufacturer or distributor with a note that they must comply with the terms and conditions set by each drug manufacturer (Yusuf, 2020). The purpose of the drug claim is to exchange drugs with close expiry dates to become drugs with long expired dates so that they can be safely resold. Therefore, a reverse logistic approach can be applied as a planning and implementation process in drug claims that are approaching expired.

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then the reverse logistics process does not always run well, causing the accumulation of expired claim drugs in the expired drug warehouse of PT. XYZ and creates dead stock of drugs from the claim process. Therefore, in this study the authors wanted to know how the reverse logistics process capability for expired drug claims in the warehouse of PT. XYZ.

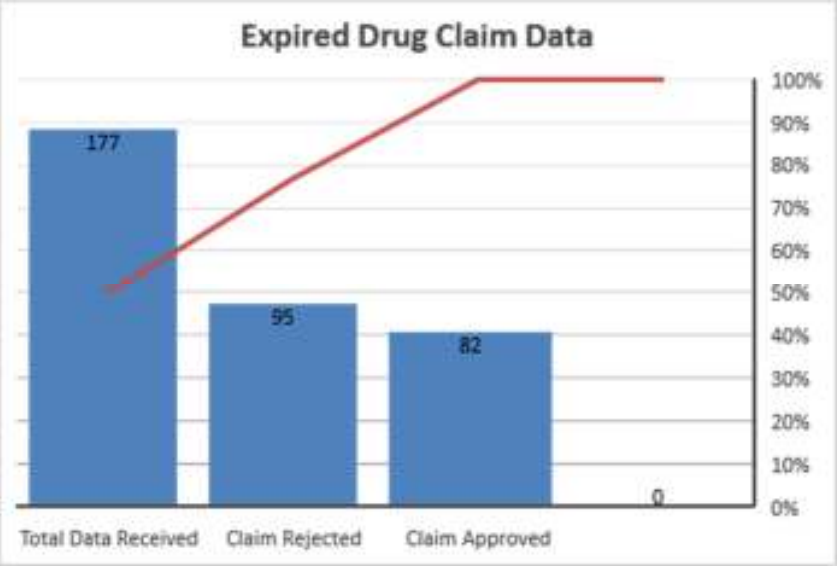

Figure 1. Percentage of drug claim delivery data to the warehouse.

It can be seen in Figure 1. above, there are 95 drug claim data that were rejected from a total of 177 expired claim drug data that entered the Jakarta logistics center warehouse in the September 2021 period with a reference time of return, which is 3 months before expired. In the case of reverse logistics of drug claims, in order to maintain the smoothness of the claim process and find out the value of the reverse logistics process capability for expired drug claims. Reverse Logistics is the process of organizing, executing and monitoring the efficient and economical movement of raw materials, the movement of information and related data from the point of

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consumption to the point of origin for receiving back or to ensure proper disposal (Akhor, 2016). the Six Sigma method approach can be used. According to Lertanantasuk (2013) the six sigma method is one of the most effective methods of solving dead stock problems to help reduce dead stock in case studies that occur in the warehouse of a construction equipment trading company.

According to Wahyani (2010) Six Sigma is a comprehensive system, because it is a discipline-based technique and method to assist in achieving business success, where Six Sigma is focused on continuous improvement. The success of improving the quality and business performance of this company, depends on the ability to identify and solve problems that occur.

Based on the background of this research above, the formulation of the problem made by the researcher is as follows:

1. How is the value of process capability and sigma value of reverse logistics distribution at expired drug warehouses at PT. XYZ?
2. Why is there an accumulation of claim drugs?
3. What are the appropriate steps for improvement in the reverse logistics process for drug claims?

Method

This research uses a mixed method research approach. The analysis technique in this research uses the six sigma DMAIC method. The application of six sigma using the DMAIC concept, for the stages in implementing the six sigma D-M-A-I-C method starting from the define stage, measure stage, analyze stage, improve stage, and finally the control stage (Wahyani, et al., 2010). The following are the steps of analysis in this research:

1. Define

   At the DMAIC stage, define is the initial step carried out in six sigma,

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Define is done by making a description of the production process, the stages in the define process that will be used in this study are as follows:

a. SIPOC. SIPOC Analysis used to present a glimpse of the work flow from suppliers, inputs, processes, outputs, and customers
b. Critical To Quality. identify the most common problems.
c. Pareto Charts. are used to display the most important factors or factors that have the most influence on other factors. and then measurements are carried out using a control chart that calculates the lower and upper limits in order to find out whether the repair process needs to be carried out. Thus, the Pareto diagram is used to map the biggest problems based on the results of CTQ analysis.

2. Measure

at this stage to measure and identify the causes of non-conformance in a process and this stage also focuses on understanding the performance of the selected process for improvement.

a. Calculation of Defects Per Million Opportunities (DPMO) and sigma capabilities.
b. Control Chart. Is a tool to determine whether a process is under control or not by looking at the results of the control chart. Xbar-R with the help of Minitab 21 Software.
c. Sufficiency Test of data. is to determine whether the measurement data for research that has been collected is sufficient or not. So if it

$$N' = \left[\frac{\frac{k}{s}\sqrt{N.\sum Xi^2 - (\sum Xi)^2}}{\sum Xi}\right]^2$$

is not enough, data collection must be carried out again. Below is the data adequacy test formula.

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Explanation:

N' : Amount of Theoretical Data

N : Amount of Sample Data

S : Degree of Accuracy

K : Confidence Level (99% ≈ 3, 95% ≈ 2, 68 ≈ 1)

X : Mean

Conclusion, if N' < N then the data is considered sufficient.

d. Process Capability Test. Is an effective method to analyze the ability of a process to produce products that meet standards. Process Ability Test, the minimum value for the ongoing process is Cp = 1.33 and for the newly running process is Cp = 1.50 (Poncotoyo et al., 2019)

3. Analyze

The analysis stage does important things in the problem solving process, namely the process of finding the root of the problem from the reverse logistics process for drug claims approaching expired date which causes the accumulation of expired claim drugs and dead stock of drugs in the Jakarta logistics center warehouse PT. XYZ.

a. Cause of Effect Diagram or Fishbone Diagram. The cause-and-effect diagram is a structured method that allows a more in-depth investigation of a problem in identifying the cause of the problem (effect) compared to the difficulty of separating the cause from the effect (Ainun Najib, 2019).

4. Improve

The improve stage aims to plan actions to minimize the occurrence of problems in the company. At this stage, identification and description of corrective actions will be carried out in order to find proposed solutions to problems in order to improve the quality according to the

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target of the company to be better and more efficient. The analysis technique at this stage uses the 5W+1H method (Somadi, 2020). The meaning of 5W + 1H in this study is what means what problems occur, when means when the improvement plan is implemented, where means where the improvement plan is implemented, why means why it needs to be repaired, who means who is responsible for repairs, and how meaningful how the repair procedure is carried out. The stages in using the 5W + 1H analysis are as follows (Ritonga, 2017):

1) What, means what problems will be repaired?
2) Why, which means why it needs to be repaired?
3) Where, means where will the repairs be done?
4) When, means when the repair will be done?
5) Who, meaning who is responsible for the improvements to be made?
6) How, means what is the strategy to overcome the problems that will be repaired?

5. Control

In this control phase, monitoring of the process is carried out to ensure that the changes that have been made are appropriate and by maintaining the conditions that have been set in the improve phase. Control (control) is carried out for a certain period of time to ensure that the improvements made have actually answered the existing problems. The analytical technique used at this stage is the creation of a Standard Operational Procedure (SOP).

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Discussion and Result

Based on the data from the data collection, various data processing and analysis were carried out. The following are the results and discussion related to the results of data processing that has been carried out.

1. Define

Define stage is a stage to identify problems in research. The problem described in this study is related to the problem of drug accumulation that occurred in the warehouse of the logistics center of PT. XYZ drug claims division:

a. SIPOC

SIPOC stands for 5 elements in a quality system covering Supplies, Input, Process, Output, Customers

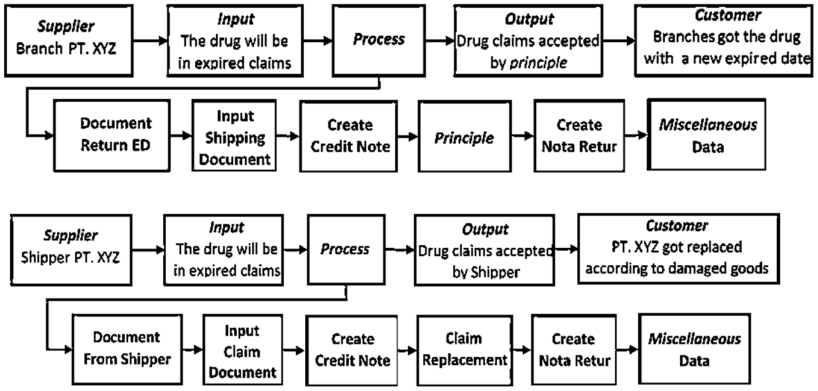

Figure 2. SIPOC Diagram Claim Expired Drug Process

Figure 3. SIPOC Diagram Claim of Delivery Damaged

It is known that the reverse logistics process for the return of claims for expired and damaged drugs is expected. The expected output of the process is the smooth running of the claim process. However, in practice, the process does not always run well, resulting in the accumulation of expired claim drugs in the logistics center warehouse of PT. XYZ drug claims.

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b. Critical To Quality (CTQ)

Critical To Quality (CTQ) results are based on the process from the SIPOC diagram and then based on the results of stock control data processing that has been collected by the author for this study.

Table 2. Expired Drug Claim Process Data

Process	Total Claim Process Data	Total Claims Received	Total Claims Rejected
Claim Expired Drug	177	82	95

Tabel 3. Damaged Drug Shipping Return Process Data

Process	Total Claim Process Data	Total Claims Received	Total Claims Rejected
Damaged Drug Returns	105	82	23

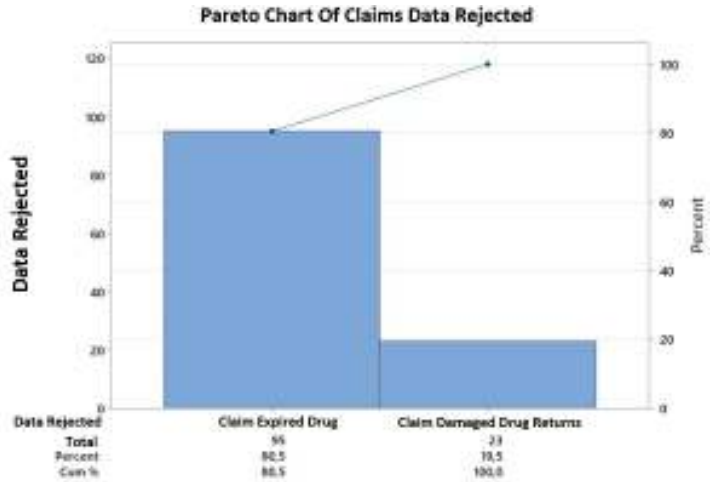

Figure 4. Pareto Diagram Problem Identification Results

The results of the Pareto Diagram analysis above show that the highest frequency of problems causing drug accumulation in the drug warehouse for expired claims of PT. XYZ, that the data for rejecting expired claims is higher than the data for rejecting the return of expeditionary damaged drugs with a frequency of 80.5% : 19.5%.

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Based on the frequency comparison, the problem to be analyzed in this study in the next stage is the rejection data from expired claim drugs.

c. Data Normality Test

The data normality test for this study is shown to test whether in the regression model, the confounding or residual variables have a normal distribution or not in this research data (Hafidz Nasution, 2020). The normality test of the data use Minitab 21 software. with a total number of 95 data or n = 95. normality test of the data used was the Kolmogorov Smirnov (KS) test

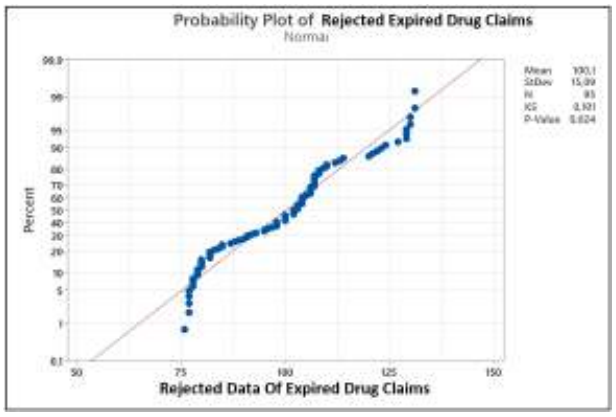

Figure 5. Normality Test Data Of Rejected Expired Drug Claims

The results of the Normality Test for Rejection of Expired Drug Claim Process with the calculated value in the KS table can be seen that the KS value for two-sided testing with data sample size (n) is 95 data and the accuracy level with (α) 5% is 0.137. The result of the KS calculation of the Rejection Data for the Expired Drug Claim Process is 0.101. In conclusion, the data is normally distributed because of the Minitab < software calculation rather than the table KS.

2. Measure

a. Calculation of defect per million opportunities and Sigma Level

It can be seen at table 2. that there are 177 expired drug claim

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processes running with a total of 95 rejections. The calculation is done with the formula and method below.

N (Rejected Claims) = 95 Data

N (Approved claims) = 177 Data

Opportunities = 1 Deffect

Calculation:

$$\text{DPO} = \frac{Sum\ Of\ Rejected\ Claims\ Data}{Sum\ Of\ Approved\ Claims\ x\ Opportunities} = \frac{95}{177\ x\ 1}$$

$$\text{DPO} = 0{,}5367$$

$$\text{DPMO} = \text{DPO x } 1.000.000$$
$$= 0{,}5367 \text{ x } 1.000.000$$
$$= 536.700$$

Next is the calculation of the Sigma Level use Microsoft Excel Software with the formula:

$$\text{Sigma Level} = \text{NORMSINV}(1 - \text{DPMO}/1.000.000) + 1{,}5$$
$$= \text{NORMSINV}(1 - 536.700/1.000.000) + 1{,}5$$
$$= 1{,}407877 = 1{,}4$$

Note: The value 1.5 is the value of the variance shift for the six sigma quality level. Based on the above calculations, it can be seen that the DPMO is 536,700 times defect per million opportunities. With a DPMO value of 536,700, the Six Sigma value is 1.4 and the probability of being free from defect is 30.23%, which means that the probability of an expired drug claim process being accepted is 30.23% and the probability of a rejected drug claim process being 69. 77%. From the value of the probability level of the error process, improvements need to be made to minimize the opportunity for the level of repulsion that will occur.

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Table 4. Dpmo Calculation Results and Sigma Level

Data Type	Claim Process Data	Approved Claim Data	Rejected Claims Data	Percentage Rejected	DPMO	Sigma Level
Tolakan Klaim ED	177	82	95	69,77%	536.700	1,4

b. Control Chart

The use of this Control Chart aims to control the process by detecting the causes of unnatural variations (special causes) or called process shifts (the occurrence of shifts in the process), as well as to minimize variations in the process. This results in a stable process. Xbar-R control map that was created using the Minitab 21 software (Thanthirige et al., 2016),

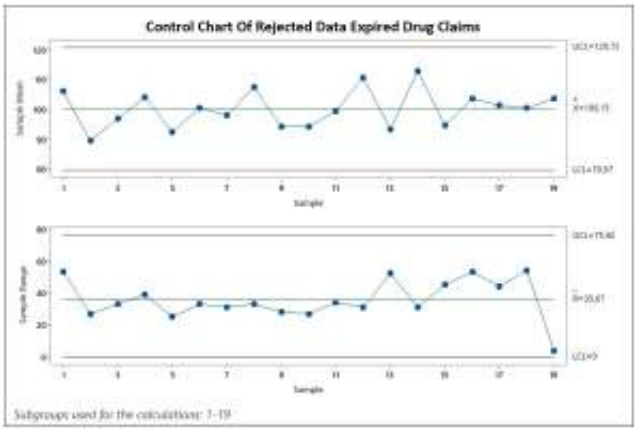

Figure 6. Control Chart Xbar-R data expired drug claims

it can be concluded that the rejection data of expired claim drugs of PT. XYZ is in the area between the upper and lower limits, with the conclusion that the claim rejection data expires is in control.

c. Data Sufficiency Test

Data Sufficiency Test is to find out whether the measurement data for research that has been collected is whether the data is sufficient or not for research.

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Information:

N : 95

k : 95%, So K= 2

s : 5% ≈ 0,05

∑xi^2 : 191,292

∑xi : 1,903

(∑xi)^2 : 3,621

$$N' = \left[\frac{\frac{k}{s}\sqrt{N.\sum Xi^2 - (\sum Xi)^2}}{\sum Xi}\right]^2$$

$$N' = \left[\frac{\frac{2}{0,05}\sqrt{95 \times 191,292 - 3,621}}{1,903}\right]$$

$N' = 8,027 \approx 8$

conclusion: N > N' = Data is sufficient

The results of the calculation of the data adequacy test conclude that the data is sufficient, namely the amount of (N) Actual Data is greater than (N ') Theoretical Data then can be continued for the calculation of process capability.

d. Calculation Process Capability (Cp)

Then the capability process was using the minitab 21 software.

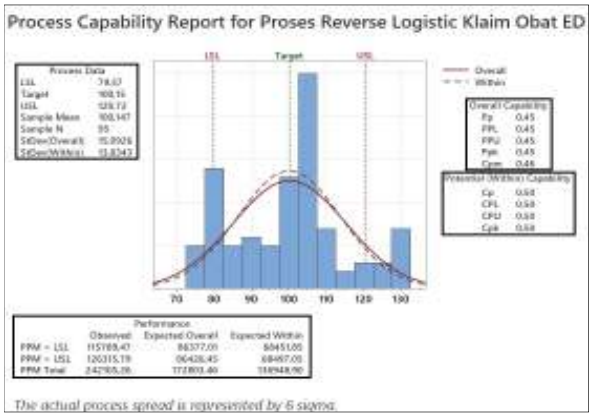

Figure 7. Capability Process Reverse Logistic of Expired Drug Claims

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Based on the results of the Xbar-R control map in Figure 6, the upper control limit (UCL) = 120.72 and the lower control limit (LCL) = 79.57. Result of Capability Measurement of Reverse Logistic Distribution Process for Expired Drug Claims PT. XYZ with Cp = 0.50 and Cpk = 0.50 These results indicate that the ability to process expired drug warehouses in the reverse logistics distribution process for expired drug claims by PT. XYZ has a low or poor value because it does not reach the recommended minimum (Cp) with a minimum value for the running process is Cp = 1.33.

3. Analyze

At the analysis stage, it is carried out using a fishbone diagram to find out the roots of problem. Fishbone diagram is used to find the root cause of the problem that occurs both the main cause and the root cause of the main cause.

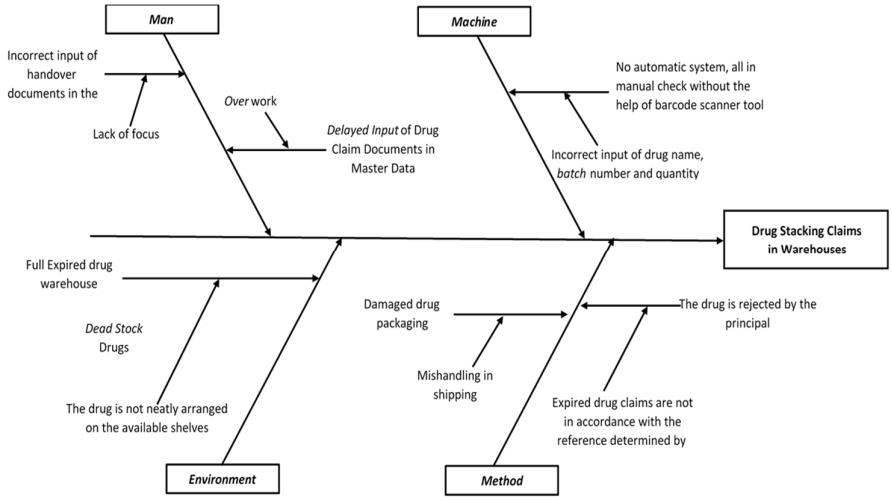

Figure 8. Fishbone Analysis

then developed and searched for the root of the problem and the impact was then clarified using the help of a fishbone analysis table below.

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Table 5. Results of Fishbone Diagram Analysis

Factors Causing the Problem	The Root of the Problem	Impact of the Root of the Problem
Man	*Over* work and lack of focus when doing the work which causes delays *in the Input* of Expired *Date* (ED) drug documents in the master data.	The standard time of workers in the company is 8 hours of work, but because *over* work results in a shortage of *man power* and the need for *multitaskting* causes overwhelmed, so the *input* of drug documents *Expired Date* (ED) in the master data for incoming drug control is finally delayed
Machine	Lack of automatic *barcode scanner* tool to help check drug name, batch number and quantity of drugs	This error in inputting results in having to re-examine the drug to be *returned* to the principal because the correctness of the drug data information is important so that there is no error in the name and type of the drug.
Method	Incorrect *handling* or handling of goods during delivery results in damaged packaging and drug contents.	If the drug packaging is damaged and the contents of the drug can contaminate and contaminate other drugs that are in one shipment.
	The drug Expired Date claim does not comply with the reference specified by the *principal.*	If the ED drug claim process is not in accordance with the provisions such as the reference time of return or the condition of the packaging, then the *principal* has the right to refuse the Expired Drug claim process of the Expire Drug.

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Environment	A warehouse full of claim drugs and dead stock drugs that are not neatly arranged on the shelves that are already available result in the warehouse feeling full and crowded.	The Expired claim drug storage warehouse that is full in addition to causing discomfort at work also results in difficulties when finding and retrieving drugs to be delivered to the *principal.*

4. Improve

In this improve stage using 5W + 1H analysis technique. The following is an explanation of the proposed analysis results using the 5W + 1H analysis table based on the root of the problem in the results of the Fishbone diagram.

Factor	Description	Explanation
Over Work That Cause *Delays In Input* Document Expired *Date* (ED) In Master Data.	*What*	*Over* work.
	When	At a time when there are many expired drug claims schedules that must be submitted simultaneously.
	Where	Warehouse office of the logistics center
	Why	To prevent the accumulation of goods due to unfinished documents being input into the master data.
	Who	Staff Admin Claims
	How	Implementation of digital document input through the Relation *Database Management System (Oracle)* between branches and central warehouses.
Staff who lack focus resulted in errors when inputting information on drug names, drug *batch* numbers and drug quantities.	*What*	Less focused staff
	When	When inputting the drug name information, the batch number of the medicine and the amount of the drug to the master data.
	Where	Warehouse office of the logistics center
	Why	So that the staff does not enter the wrong information on the name of the drug, the batch number of drugs and the number of drugs into the database.
	Who	Staff admin Claims

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	How	Designing an automation system using a *barcode* containing information on the name of the drug, *the batch* number of drugs and the number of drugs sent then the staff *scans* using a *Barcode Scanner* that is directly connected with a database owned by the jakarta logistics center warehouse.
Mishandling or handling of goods during the delivery or receipt of drugs in the warehouse results in damaged packaging and contents of the drug.	*What*	The packaging of the drug is damaged.
	When	When handling drugs expired claims.
	Where	Logistics center warehouse
	Why	The packaging of the drug is damaged due to poor handling.
	Who	Warehouse staff
	How	Warehouse staff must work according to the standards of handling drug shipment packages made by the company, for example, such as not throwing or slamming drug packages.
The drug's ED claim does not conform to the reference prescribed by *the principal.*	*What*	The claim of expired medicine was rejected by the principal.
	When	When sent to the *principal* for expired drug claims.
	Where	Warehouse of drug claims.
	Why	the process of claiming expired drugs is not in accordance with the terms and conditions by *the principal,* such as the reference time of return or the condition of the packaging,
	Who	*Main* PT. MPI
	How	improves the quality of information and establishes good communication between warehouse employees of the jakarta logistics center and branch employees and makes time reference notifications for expired drug claims in *oracle.*
The warehouse is full of expired claim drugs and dead stock drugs.	*What*	The medicine warehouse is full.
	When	When temporary storage of the drug claims expired.
	Where	Warehouse of expired drugs

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	Why	So that there is no accumulation of drugs in the warehouse hallway.
	Who	The staff of the expired medicine warehouse.
	How	Warehouse staff must compile expired claim drugs according to the name of the principal on the available shelf and there is a mark according to the name of the principal of each drug

5. Control

At the last stage is control, which is the control of the analysis stage. At this stage, a Standard Operational Procedure (SOP) will be used which is intended for all people involved

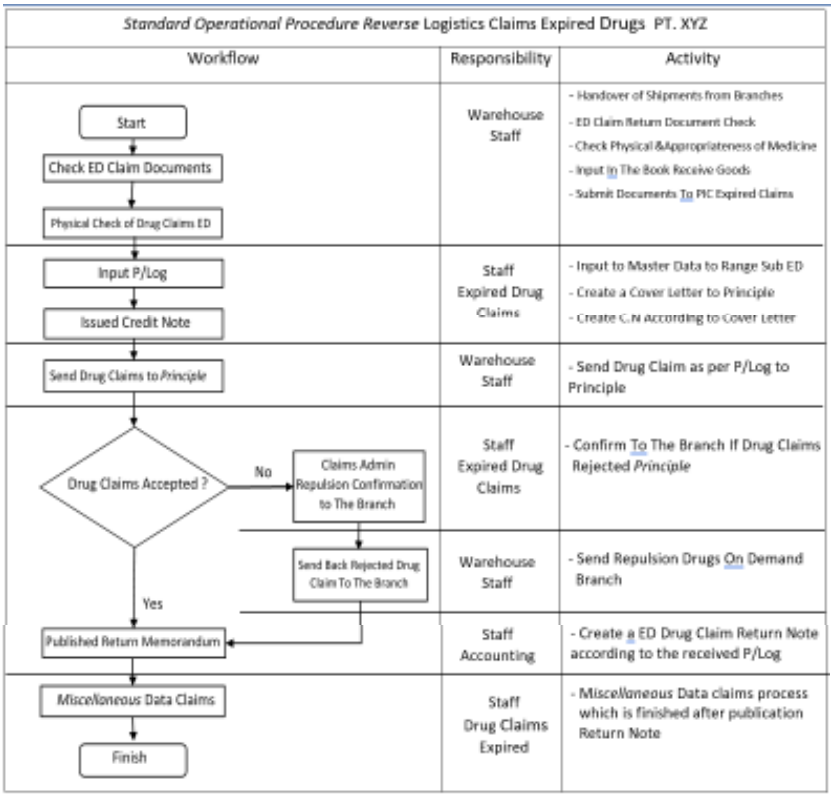

Figure 9. Standard Operational Procedure

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Conclusion

Based on the results of research that has been carried out in an effort to analyze the quality of reverse logistics distribution at expired drug warehouses of PT. XYZ using the Six Sigma DMAIC. It is known the value of the reverse logistics distribution process capability in the warehouse of expired drugs at PT. XYZ, based on normal and sufficiently distributed data. It was concluded that with the process capability value Cp = 0.50, the result showed a low or poor capability value because it did not reach the recommended minium (Cp) with a minium value for the running process, which was Cp = 1.33. And the sigma value of the problem in this study based on the results of the Defects Per Million Opportunities (DPMO) value at the Measure stage is DPMO = 536,700 and the achievement rate of the sigma value is 1.4 Sigma, which is concluded to be in the category of very uncompetitive.

Factors causing the accumulation of drugs near expired in the warehouse of expired drugs based on a causal diagram (Fishbone Diagram) which consists of several main factors, namely: Human resources (Man), Machine (Machine), Method (Method), Environment (Environment). The highest causal factor based on Critical To Quality (CTQ) at the Define stage is an expired drug whose claim process is rejected by the principal because it is not in accordance with the terms and conditions then the drug becomes dead stock, and because the preparation of the expired claim drug process that is not arranged neatly according to the shelf that has been provided in the warehouse of expired claim medicine makes the warehouse environment feel crowded.

Based on the update to the Standard Operational Procedure (SOP) produced at the control stage in this study, it is hoped that it can help the

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company to make improvements to the reverse logistics process for expired drug claims so that it can improve its process capability and minimize rejection of expired drug claims in the warehouse of the Jakarta logistics center PT. XYZ.

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