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QUALITY CONTROL ANALYSIS WITH STATISTICAL QUALITY CONTROL (SQC) AND FAILURE METHODSMODE EFFECT ANALYSIS (FMEA) ON THE PRODUCTION OF ZA PLUS FERTILIZER

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Abstract. PT.XYZ is an industrial logistics company, one of whose divisions is warehousing and MBU which serves fertilizer bagging. as for the problems that occur at PT.XYZ is the bagging of fertilizers that still occur defects. The purpose of this study is to determine the percentage of defects that occur most often and the factors that cause defects. as well as provide suggestions for improving the quality of fertilizer bagging. The methods used in this research are Statistical Quality Control (SQC) and Failure Mode Effect Analysis (FMEA). SQC tools are check sheet, pareto diagram, control map, and fishbone diagram. Then continue the FMEA analysis for proposed corrective actions. Based on the results of research on Statistical Quality Control (SQC), it is known that the most dominant bagging defects are tearing defects (58%), then stitching defects (27%), defects in weighing less (15%). Based on the results of research on Failure Mode Effect Analysis (FMEA), it is known that the cause of the highest problem with RPN100 is the type of tearing defect with the cause of less carefulness during the process of putting fertilizer on the pallet. The recommendation for improvement proposals to overcome this problem is to provide work procedure training to employees so that employees understand the work procedures at PT.XYZ.
Keywords: Quality Control, Statistical Quality Control, Failure Mode Effect Analysis
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1. Introduction

The manufacturing industry is based on the need to improve product quality, process efficiency, and customer satisfaction. Each company must have its own quality standards to maintain product quality so that it can be accepted by consumers. One way to improve quality is to reduce or reduce defects and improve quality [1]. Based on the results of the initial survey, the researcher found that the production process of bagging ZA plus fertilizer PT.XYZ still has defects in the bagging results. For example, torn fertilizer bags, of course this will result in losses for the company plus the fertilizer products sent specifications are not in accordance with consumer orders, so it will potentially be returned again for repairs. Based on the explanation of the problem of bagging ZA plus which still occurs defects in the bagging process, therefore the following research is intended to determine the percentage of the most dominant defects and provide proposed actions to improve bagging quality. The results of this study can be used as input by the company to analyze the quality of products produced and determine production quality control policies in order to achieve quality products, which meet company standards [2]. One way that can be done is to apply Statistical Quality Control as a method that maintains product quality standards. According to [3], the SQC and FMEA methods can find out the main causes of defects in products and provide appropriate improvement proposals. Therefore, in accordance with the discussion above, researchers apply the SQC method to determine the causes of defects in fertilizer products and FMEA analysis to provide suggestions for improvements to the quality control of ZA plus fertilizer bagging.

2. Methods

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Quality is the most fundamental factor for customer satisfaction [4]. Therefore, quality control is needed to maintain the quality of a product [5]. This quality control research on ZA plus fertilizer products is carried out with several core stages, namely the preliminary stage, data collection stage, data processing and conclusion drawing. This preliminary stage consists of field and literature studies in order to know the existing situation combined with theories related to the SQC and FMEA methods. Furthermore, the formulation of existing problems is carried out. The next stage is data collection. The data used are production data and data on the number of ZA plus fertilizer defects at PT.XYZ. Furthermore, data processing is carried out with the help of the Statistical Quality Control method, which is an approach used in the industrial sector to measure, monitor, and regulate the quality of products or services by utilizing statistical tools and data analysis techniques. with several stages, namely Check sheet (check sheet), Histogram, Pareto chart (pareto diagram), Control Chart (control map), and Fishbone diagram [6]. Furthermore, determining the priority of fixing the problem with the help of the Failure Mode and Effects Analysis method, is a structured and systematic method of analyzing failures and recognizing, and prioritizing potential failures or defects [7]. In FMEA risk assessment, a parameter known as RPN (Risk Priority Number) is used, which is calculated as a result of multiplying the severity, frequency of occurrence, and detectability of failures [8]. A scale from 1 to 10 is used to assess severity. The severity rating scale [9] is in Table 1.

Table 1RPN severity rating scale

Ranking	Severity	Description
10	Hazardous without warning	System failure resulting in highly hazardous effects
9	Hazardous with warning	System failure resulting in hazardous effects
8	Very High	System is not operational
7	High	System is operational but cannot be run at full capacity
6	Moderate	Operational and safe but experiencing a decrease in performance that affects the output
5	Low	Gradual performance degradation
4	Very Low	Minimal impact on system performance
3	Small	Slightly affecting system performance
2	Very Small	Negligible effect on system performance
1	No Effect	No effect

The O value in the analysis describes the level of likelihood or probability of failure. A scale of 1 to 10 is used to assign occurrence values. The occurrence assessment ranking [9] is in Table 2.

Table 2RPN occurrence rating scale

Ranking	*Occurrence*	*Description*
10 - 9	*Very High*	*Frequent failures*
8 - 7	*High*	*Repetitive failures*
3 - 2	*Low*	*Very rare instances of failure*
1	*No impact*	*Almost no failures*

A D value indicates the likelihood of detecting a failure before it occurs. A scale of 1 to 10 is used to rate detection. The evaluation of detection ratings based on McDermott 2009 in [9] is shown in Table 3.

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Table 3RPN detection scale

Ranking	Detection	Description
10	Uncertain	Checking consistently lacks the capability to identify potential causes or failure mechanisms and failure modes.
9	Very Small	The likelihood of checking is extremely minimal in detecting potential causes and failure mechanisms and failure modes.
8	Small	The chances of checking to detect potential causes and failure mechanisms and failure modes are distant.
7	Very Low	The probability of checking is very low in detecting potential causes and failure modes.
6	Low	The likelihood of checking to detect potential causes and failure mechanisms and failure modes is low.
5	Moderate	The checking capability to detect potential causes and failure mechanisms and failure modes is moderate.
4	Intermediate to high	The chances of checking to detect potential causes and failure mechanisms and failure modes are quite high
3	High	The probability of checking to detect potential causes and failure mechanisms and failure modes is high.
2	Very High	The likelihood of checking to detect potential causes and failure mechanisms and failure modes is very high.
1	Almost certain	Checking consistently has the ability to detect potential causes and failure mechanisms and failure modes.

3. Results and Discussion

A. Statistical Quality Control (SQC)

Data processing uses five quality control statistical tools, following analysis using the SQC method.

1. Check Sheet

There are several steps in performing quality control with the Statistical Quality Control method, the first step is to create and fill out a check sheet. A check sheet is a simply designed inspection form that contains a list of elements that need to be recorded, both qualitatively and quantitatively. Its purpose is to tidy up and organize data collection in an easy, systematic, and structured way when the data appears at the scene [10]. The check sheet can be referred to in Table 4.

Table 4data chect sheet

NO	WEEK	JUMLAH PRODUKSI(BEG)	TYPES OF DAMAGE			AMOUNT OF DAMAGE (BEGS)
			RIPPED	SEWING	BALANCE	
1	Week 1	354	49	29	15	93
2	Week 2	377	59	20	13	92
3	Week 3	377	50	20	10	80
4	Week 4	377	60	25	12	97
5	Week 5	375	40	19	15	74
6	Week 6	375	44	30	17	91
7	Week 7	375	55	29	14	98
8	Week 8	377	56	23	11	90
TOTAL		2987	413	195	107	715

Based on Table 4. Check sheet above there are 3 types of defects. Torn defects as many as 413 bags, not sewn as many as 195 bags, and the size of the scales is less as many as 107 bags.

2. Histogram

Once the check sheet is created, the next step is to create a histogram. A histogram is a useful tool in identifying variation in processes. It takes the form of a bar graph that illustrates the grouping of data based on their values [11].

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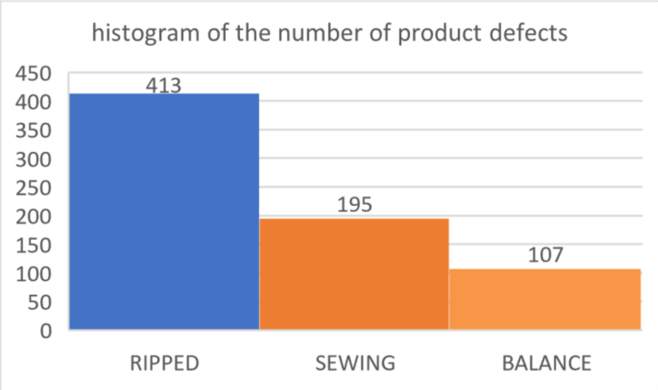

Figure 1histogram of product defects

Based on Figure 1 histogram above, it can be seen that the most common type of damage is torn fertilizer packaging with a total product damage of 413 bags. The second frequent damage is found in the packaging that is not sewn with the amount of product damage 195 bags. The third frequent damage is found in the type of weight of the scales that are less with the amount of damage 107 bag

3. Control Map

After knowing the type of defect using a histogram, then create a control map to see which defects cross the control limit with a control map. A control map is a visual instrument used to monitor and evaluate whether certain activities or processes are in quality control based on statistical analysis [12]. Steps in making a control map p:

Calculating the Percentage of Damage [$P = \frac{np}{n}$] (1)

$P = \frac{np}{n} = \frac{93}{354} = 0{,}2627$ (2)

Calculating the Centerline The centerline is the average of product damage [$CL = \text{p} = \frac{\sum np}{\sum \text{n}}$] (3)

$\text{CL} = \text{p} = \frac{\sum np}{\sum \text{n}}$ (4)

$\text{CL} = \text{p} = \frac{715}{2987} = 0{,}239$ (5)

Calculating the Upper Control Limit [$UCL = \text{p} + 3\,\frac{\sqrt{p(1-p)}}{n}$] (6)

$UCL = p + 3\,\frac{\sqrt{p(1-p)}}{n}$ (7)

$UCL = 0{,}259 + 3\,\frac{\sqrt{0{,}259\,(1-0{,}259)}}{2987} = 0{,}263$ (8)

Calculating the lower control limit [$LCL = p - 3\,\frac{\sqrt{p(1-p)}}{n}$] (9)

$LCL = p - 3\frac{\sqrt{p(1-p)}}{n}$ (10)

$LCL = 0{,}259 - 3\,\frac{\sqrt{0{,}259\,(1-0{,}259)}}{2987} = 0{,}216$ (11)

Table 5control map p

NO	PRODUCTION QUANTITY (BEGS)	AMOUNT OF DAMAGE (BEGS)	BROKEN PERCENTAGE %	CL	UCL	LCL
1	354	93	0.26	0.239	0.263	0.216
2	377	92	0.24	0.239	0.262	0.216
3	377	80	0.21	0.239	0.262	0.216
4	377	97	0.26	0.239	0.262	0.216
5	375	74	0.20	0.239	0.262	0.216

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6	375	91	0.24	0.239	0.262	0.216
7	375	98	0.26	0.239	0.262	0.216
8	377	90	0.24	0.239	0.262	0.216
TOTAL	2987	715	0.24	0.239	0.262	0.216

After the value of the percentage of each subgroup, the value of the center line (CL), the upper limit value (UCL), and the lower limit value (LCL) are known in table 5, the next step is to make a p-control map (p-chart) which can be seen in Figure 2.

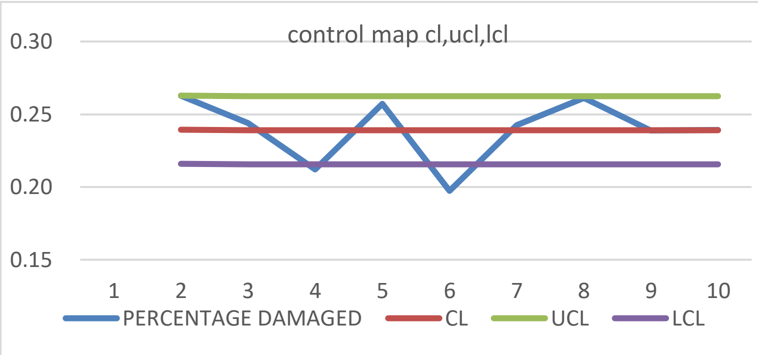

Figure 2 control map cl,lcl,ucl

From the image on the p control map above, we can see that there is still data that is outside the control limits at point 6, and the most dominant cause is damage or defects in torn packaging. So it can be said that the process is not under control or shows that there are deviations. Because there are points that are outside the control limits, this indicates that there are still problems in the production process. Therefore, it is still necessary to further analyze why the deviation of the production process at PT.XYZ by using a cause-and-effect diagram (fishbone diagram) to find out the cause of the product deviation.

4. Pareto diagram

After knowing the data about the type of product damage that occurs, a pareto diagram is made. Pareto diagram is a graphical representation in the form of bars that describe the frequency distribution of classified attribute data, which helps identify the types of product defects [13].

Table 6damage data, damage percentage and cumulative percentage

NO	DAMAGE TYPE	QUANTITY OF DAMAGE (BAGS)	BROKEN PERCENTAGE	CUMULATIVE PERCENTAGE
1	RIPPED PACKAGING	413	58%	58%
2	UNSEWN PACKAGING	195	27%	85%
3	LESS FERTILIZER WEIGHT	107	15%	100%
	TOTAL	715	100%	

Based on the results of data calculations in table 6, it can be depicted in a pareto diagram showing the comparison of the types of damage that occur

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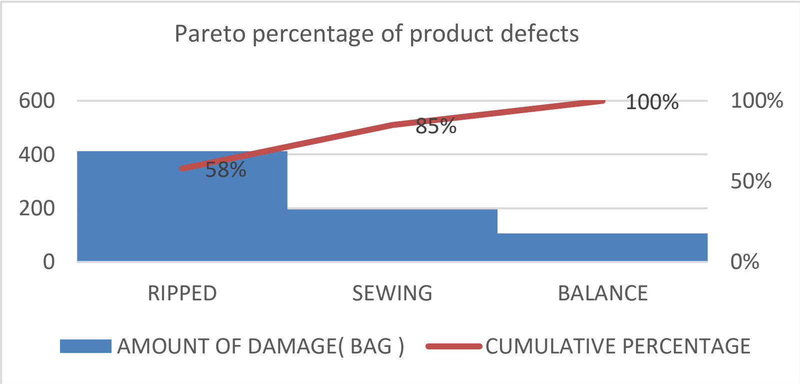

Figure 3pareto percentage of product defects

Based on Figure 3 Pareto above shows the type of damage that often occurs is the problem of torn packaging with a total damage of 413 units or 58%. Furthermore, the second type of damage that often occurs is unsewn packaging with a total damage of 195 units or 27%. Furthermore, the third frequent damage is the lack of scales with a total damage of 107 units or 15%.

5. Cause-and-effect Diagram

After knowing the type of defect that most often occurs, then identify what factors affect the defect by using a fishbone diagram. Fishbone diagrams, also known as cause-and-effect diagrams, are used to uncover and identify triggering factors that underlie the occurrence of failures or defects [14]. The causal factors of the three types of damage (defective products) in ZA plus fertilizer products are described using the fishbone diagram below:

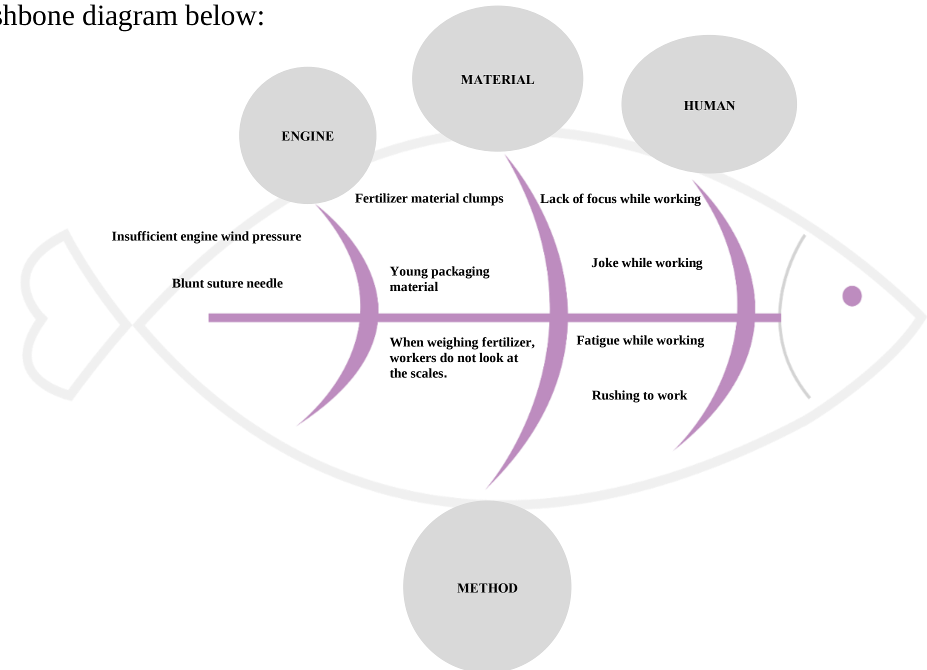

Figure 4 cause-and-effect diagram

Judging from Figure 4 of the cause-and-effect diagram above, there are four indicators of the causes of disability, namely humans, machines, materials and methods.

B. Failure Mode Effect Analysis (FMEA)

After processing the data with Statistical Quality Control, information is obtained where defects that often occur are torn, followed by stitching defects and scale defects. Furthermore, according to the cause and effect diagram, the causes of jimbe drum production defects are known to be carried out proposed

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corrective actions using Failure Mode Effect Analysis (FMEA) analysis by determining the Risk Priority Number (RPN) results shown in the table below.

Table 7RPN assessment

Potential Failure Mode	*Potential Effect of Failure*	S	*Potential Cause*	O	*Current Control*	D	RPN
Ripped packaging	Fertilizer products will not be able to be sold and will do the work twice because they have to change the packaging	9	1.workers lack focus when arranging pallets	5	1.Always supervise workers so that they do not focus on other things.	2	90
			2. workers are in a hurry when placing fertilizer on pallets	9	2.Supervise workers not to be hasty in arranging fertilizer onto pallets.	4	324
			3.workers talking to fellow workers	5	3.reprimand workers who talk	2	90
			4.worker fatigue due to heavy fertilizer load	6	4.implementing changes every few minutes to avoid fatigue	2	108
			5.compressor wind pressure to hydraulic less	8	5.perform regular maintenance to the compressor	3	216
Unsewn packaging	Fertilizer will spill and scatter and the fertilizer will have to be re-sewn.	7	1.the stitches wear out so that there is often a jam when sewing	6	1.change sutures at regular intervals	3	126
			2.workers are in a hurry when sewing so they do not pay attention to the position of the sack when sewing	7	2.inspect the stitches when they are completed	4	196
			3.talking to fellow workers so as not to pay attention to the position of the sack when sewing	5	3.reprimand workers who talk	3	105
Weighing the packaging scales less	Workers have to repackage until the weight matches the size	5	1.less wind pressure makes the automatic weighing machine inaccurate	5	1.always check the pressure indicator	3	75
			2.haste - haste does not see the indicator scales	4	2.check the scale again	1	20
			3.less thorough when looking at the weighing indicator	4	3.make sure the scale indicator is correct	2	40

Table 8RPN rank assessment

Priority	*Potential Failure Mode*	*Potential Cause*	RPN	*Recommendation*
1	Ripped packaging	workers are in a hurry when putting fertilizer onto pallets	324	Provide them with work procedure training
2	Ripped packaging	compressor to hydraulic air pressure is less	216	Before carrying out work activities, you should check the work tools.
3	Unsewn packaging	workers are in a hurry when sewing so they do not pay attention to the position of the sack when sewing.	196	Provide them with training on work procedures
4	Unsewn packaging	stitches wear out so there is often slippage when sewing	126	Check the condition of the sewing needle when it will be used and replace it regularly
5	Ripped packaging	worker fatigue due to heavy fertilizer load	108	Changing workers to avoid fatigue
6	Unsewn packaging	talking to fellow workers so that they do not pay attention to the position of the sack when sewing	105	Briefing workers on work procedures and supervising them.
7	Weighing the packaging scales less	insufficient wind pressure makes the automatais machine scales inaccurate.	75	Look at the pressure indicator first to see if it is correct before doing the work.
8	Ripped packaging	workers talk to fellow workers while working	90	Reprimand and give witnesses to workers who violate the rules.
9	Ripped packaging	workers lack focus when arranging palet	90	Give one kind of workload so that workers are more focused.
10	Weighing the packaging scales less	less careful when looking at the weighing indicator	40	Rechecking fertilizer weights
11	Weighing the packaging scales less	in a hurry not looking at the scale indicator	20	Rechecking fertilizer weights

Based on the results of the RPN (Risk Priority Number) calculation in tables 7 & 8, it is known that the causes of failure that cause product defects are sorted from high to low value calculations to provide recommendations for improvement of each cause of failure (potential cause). The recommendations based on the order of RPN can be seen in the table. The table shows the cause of defects with the highest RPN value of 324, namely torn packaging defects caused by hasty workers when placing kepalet fertilizer due to pursuing targets so that the fertilizer is slammed, and recommendations for improvement provide targets that are in accordance with the capacity of workers so that they can work properly so that no slamming occurs.

4. Conclusion

From the results of studies that have been conducted by researchers in the production department of PT.XYZ regarding ZA plus fertilizer products, it can be concluded that the dominant defect in fertilizer production is tearing with a percentage of (58%), followed by stitching defects of (27%), then defective

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scales of (15%). Factors causing tear defects are in terms of humans being less careful during the process of laying onto pallets, then in terms of machines, namely worn or less sharp hagit needles, in terms of material, namely packaging that is too old so that young is torn. Based on the results of the RPN calculation for FMEA fertilizer products, several risks are obtained that have the highest priority level for making improvements to reduce the possibility of errors. Calculation of the highest RPN value is 324 of the type of defect Torn with the cause of less careful when the process of putting kepalet or in banting. However, it is important to conduct further research with more data and longer time.

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