ISSN-p: 2085-1431
ISSN-e: 2654-5799

Analysis of packaging quality control of PT. LMN using the seven tools method and new seven tools

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ARTICLE INFO

Article history
Submission: 11th June, 2024
Revised: 23th July, 2024
Accepted: 24th July, 2024

Keywords
Quality
Continuous Improvement
Seven Tools
New Seven Tools
Packaging

https://doi.org/10.22219/oe.2024.v16.i2.109

ABSTRACT

Product quality is a crucial factor that influences success in the market and in the company's production process. Quality products meet company standards and consumer expectations. The aim of this study is to identify the causes of product rejections and to analyze process improvements in terms of man, material, machine, method, measurement, and environment to reduce product rejections. The results of data collection show the dominant types of rejects, with the following proposed improvements: Maintain the operators' job desk so that they become experts in one area, by motivating them through rewards to improve work quality. Ensure spare stock, efficient forklift lanes and H-1 glue communication. Make continuous improvements in every part of the packaging department and build an information system for glue type requirements. Place SOPs in a visible and obvious location, add machine filters near operators, and improve machines to prevent overweight/underweight rejects. Check and calibrate machines regularly, implement scheduled machine maintenance checklists, and standardized maintenance and delegate tasks to optimize staff schedules. Regularly update the parts list according to the machine specifications, make a tool to pour glue from the drum with minimal noise, and perform regular machine maintenance and use bearings to reduce vibration.

1. Introduction

In an industrial environment, one of the indicators that determine the success of a company is the quality of products or services provided to consumers. At this time of development in an increasingly sophisticated and modern industry, the quality of products and production processes that are passed are important factors that determine the quality of the company's competitiveness. PT. LMN which is one of the companies engaged in manufacturing with products in the form of glue (plant adhesive) and paint (plant coating). One of the obstacles that is often experienced by companies related to rejected products is the loss in cost and waste of time in the process of recycling the products produced. This occurs due to the lack of effectiveness of the implementation of the 5M + 1E system, which includes man, machine, material, method, measurement, and environment.

According to (Daga, 2017), Product quality refers to a product's capability to perform its intended functions, encompassing durability, reliability, accuracy, ease of operation and repair, as well as other valuable attributes. Furthermore, product quality is a crucial factor in determining a product's success in the market. In addition, quality is a major factor in the production process of a product, so it is necessary to supervise the production process (Sri Mukti Wirawati, 2021). Products are the centre of marketing activities because they are the results that companies offer to the market for consumption and a tool to achieve company goals. Rejected products are products that are not accepted by company or consumer standards. A good problem statement (rejected product) can be determined by

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identifying the customer and the most important determinants of customer satisfaction are considered in Critical To Quality (CTQ). Understanding the customer's CTQ will help to resolve the most important factors (Fitriana et al., 2021). Quality control can broadly be defined as a system that ensures a desired level of quality by monitoring product or service characteristics and implementing corrective actions when these characteristics deviate from specified standards. It is crucial for companies to perform quality control to minimize the occurrence of rejected products. (Simarmata & Septiari, 2023).

The seven tools include flowcharts, check sheet, scatter diagram, histogram, Pareto chart, fishbone diagram, and control chart. Flowchart, according to (Syifa Aunillah et al., 2022), a flowchart is a diagram that illustrates the steps from one process to another in a way that is easy to understand. Checksheet, a check sheet is a tool used for data collection. Check sheets can be used for various functions, such as tallying the number of products or services produced and recording the defects or errors in the products. (Aziz, 2019). Scatter Diagram, is the simplest way to determine the relationship between two variables (x and y. From these points, the relationship between variable x and variable y can be determined, whether there is a positive or negative relationship (Ariani, 2020). Histogram or bar chart, is a tool used to depict the progression of a research subject over time based on the distribution of collected data. Histograms serve various functions, such as transforming large datasets into a tabular format and displaying the relative frequency of different data values. (TOBING, 2018). Pareto Chart commonly known as the 80/20 rule, is applicable in many aspects of life. This principle asserts that 20 percent of the problems have 80 percent of the impact, and only these 20 percent are crucial (Vital Few). The main focus of the Pareto Principle is to tackle the root cause of problems for greater efficiency and effectiveness. (Sunarto, 2020). Fihsbone Diagram, (Chandra Das, 2018) identifying fishbone diagrams is a great tool for investigating problems when it is necessary to determine the root cause. It provides a process for clearly defining 'Effect' causal factors based on common problem categories in manufacturing. Control Chart is a line graph utilized to monitor the trend or performance of a process. It features control limits, including a center line (CL), an upper control limit (UCL), and a lower control limit (LCL), which define the range for normal operation. According to (Inayah et al., 2023), once the data is processed using control charts, deviations can be identified early and action can be taken before the process becomes uncontrollable.

New seven tools include affinity diagram, interrelationship diagram, tree diagram, matrix diagram, matrix data analysis, activity network diagram, and process decision program chart. Affinity Diagram, according to (Agus Setiawan, 2023), the function of the affinity diagram is to break down the problem of product defects that often occur in companies into more specific causal groups so as to understand the problem as a whole. Interrelationship Diagram, the purpose of a Interrelationship diagram is to identify the relationships between various issues related to a problem. It can be used as an extension of the affinity diagram and can be used in conjunction with the affinity diagram. Tree Diagram can be used to identify the steps needed to solve a problem. This method offers tactical planning in a specific sequence, aiding in the development of a system of strategic solutions for current issues. (Grigoryan & Golubkova, 2020). Matrix Diagram is a tool that is utilized to recognize, examine, and assess connections among two or more variables. In book (Helmold, 2021), Matrix diagrams are employed to ascertain and assess the connections between elements within two distinct systems. Matrix Data Analysis is used to make decisions involving multiple criteria and alternatives. According to (Lafeniya & Suseno, 2023), matrix data analysis is used to show the strength of the relationship between variables and collect data from several respondents regarding the factors that cause product defects and their improvement alternatives. Activity Network Diagram is used to determine the project completion duration (the time required from start to finish) and to identify the project critical path. According to (Faturohman, 2024), Activity network diagrams are used to sequence the production process, focusing on the stages that cause product defects, thus enabling decisions that can improve productivity. Process Decision Program Chart serves as a tool for preparing for unforeseen circumstances. It is effective for executing or enhancing a plan or program. According to (Gilang Kistianto & Prakoso, 2023), Process Decision Program Chart is used to map out the various options that can be taken by considering the system as a whole, including the company's capabilities and its resources.

The seven tools and new seven tools methods each have their weaknesses: the seven tools are unable to show the relationship between factors affecting the target, while the new seven tools are more complex and require a deeper analytical understanding. The advantage of combining the two is that it provides a holistic approach that allows for more accurate data analysis and a deeper understanding of issues that cannot be measured by numbers alone.

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The purpose of this study is to identify the factors causing the highest percentage of rejects in glue product packaging using the Seven Tools and New Seven Tools methods. The dependent variable is packaging quality improvement, while the independent variables are the 5M + 1E factors (man, material, method, machine, measurement, and environment). The Seven Tools method provides a quantitative, objective analysis, offering consistent and reliable results. In contrast, the New Seven Tools method allows for a deeper, more complex analysis, incorporating qualitative data to address issues not measurable by numbers alone. By combining these methods, the company can more effectively identify and address the factors impacting packaging quality.

2. Methods

Data Collection Method
Data collection is carried out using interviews, which is a way to obtain data about the company's general description and company management. using quantitative analysis used for numerical and qualitative data collection, which is a method used to analyse non-numerical data, literature study is used as a method to obtain the meaning of quality, quality control, and methods in the seven tools and new seven tools from experts' books and research journals, field observations to find out the state and production system directly in the field. All of the above data collection methods can collect reject data and identify the root cause of product reject problems.

Data Analysis Method
Data analysis for the seven tools method includes collecting reject data and the causal factors involved, as well as analysing process performance over a period of time. Data analysis for the new seven tools method includes organising ideas as factors and developing more detailed factors and analysing the relationship between various factors that affect the quality of a product.

Operational Definition of Variables
The operational definition of a variable includes detailed indicators of the variable, which allows researchers to systematically collect relevant and appropriate data. Thus, the researcher can ensure that the data collected truly reflects the variable under study, facilitating accurate analysis and validity of the research results.

Table 1 Dependent variable of research

Dependent Variable	How to Measure	Measuring Tools
Reject product (%)	Recording the frequency of rejected products in production activities	Checksheet

Tabel 2 Independent variable of research

Independent Variable	How to Measure	Measuring Tools
Human Performance (Man)	Individual performance evaluation	Direct observation
Effectiveness of Working Methods (Method)	Evaluation of work procedures (SOP)	Standard operating procedure (SOP)
Material Quality (Material)	Matching with raw material standards	Direct (visual) measurement
Machine Reliability (Machine)	Machine performance monitoring	Direct observation
Measurement Accuracy (Measurement)	Evaluate the accuracy of measuring instruments	Comparison with measurement standards
Quality of Work Environment (Environment)	Direct observation	Environmental condition parameter standards

The research flowchart can be seen in the Fig. 1.

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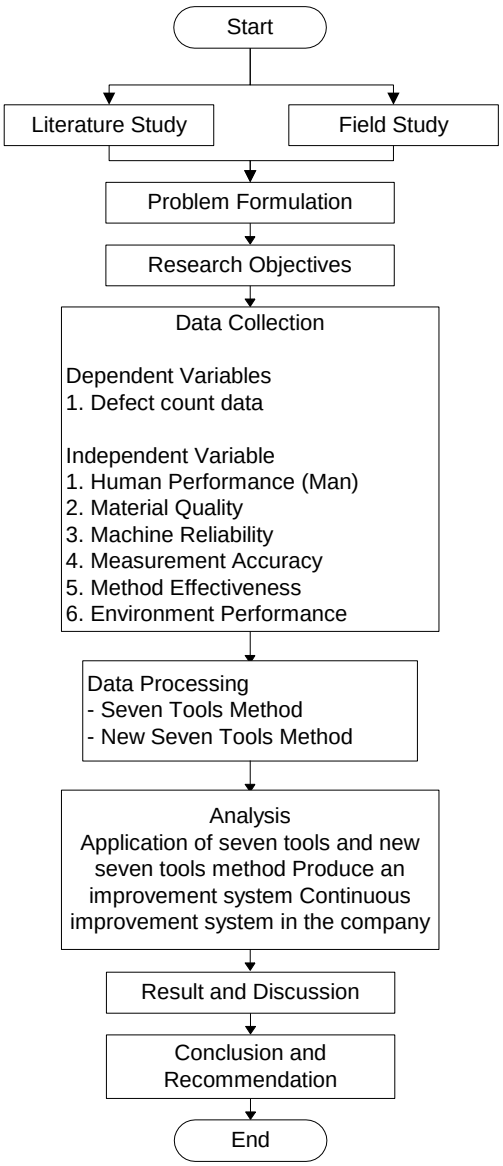

Fig. 1 Research flowchart.

3. Results and Discussion

3.1 Seven Tools of Quality Method

The seven tools of Quality Control are tools used in quality management and process improvement. It refers to seven tools commonly used by quality management and process improvement professionals to analyse problems, collect data, and develop effective solutions.

Flowchart

It can be seen in the filling process (Fig. 2), wrapping process, inner box inspection process, and outer box inspection process. inner box inspection process, and outer box inspection process. Where in the process There are reject products with less or more weight, damaged dry soap, damaged wet edge, inner box damage, and outer box damage were found.

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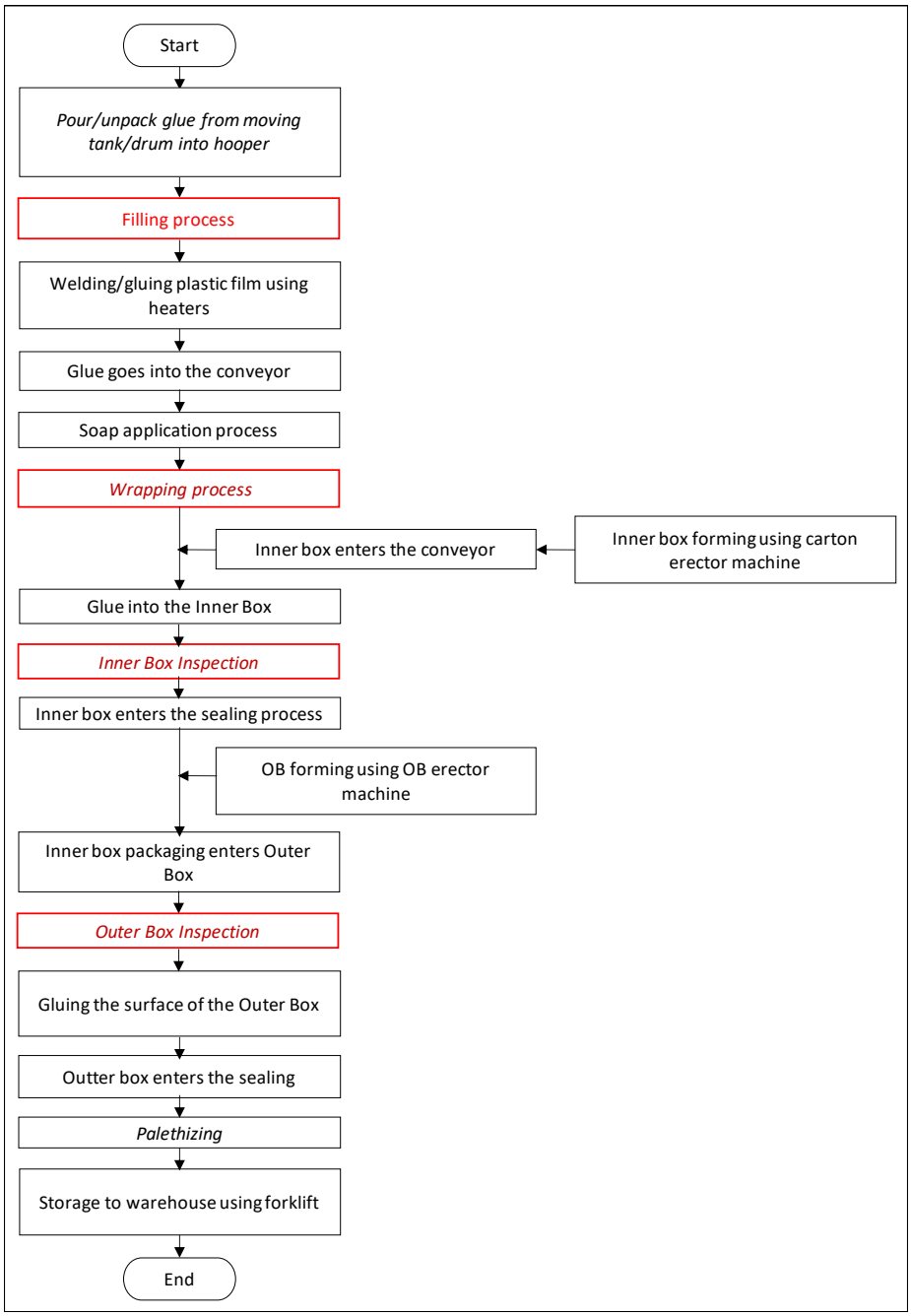

Fig. 2 Data processing with flowchart

Checksheet

From the production and reject data from January to March 2024, there are five types of rejects: under/over product, soap dry damage, wet edge damage, inner box damage, and outer box damage (see in Table 3). Out of a total of 18,223 rejects, the largest was product less/more (9,239 units), followed by inner box damage (4,038 units), soap dry damage (2,638 units), wet edge damage (1,660 units), and outer box damage (648 units).

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Tabel 3 Data processing with checksheet

No.	Month	Week Period	Total Production (Bags)	Jumlah Reject					Number of Rejects
				Weight less/more	Broken dry soap	Broken wet edge	Inner Box Damage	Outer Box Damage	
1	January	1	420717	239	150	167	182	27	765
2		2	528328	432	272	239	237	21	1201
3		3	543520	872	267	188	293	36	1656
4		4	680576	1420	426	301	528	79	2754
5	February	1	434034	673	181	125	175	47	1201
6		2	286497	255	128	35	142	19	579
7		3	256750	108	79	92	60	3	342
8		4	298646	1215	150	68	111	2	1546
9	March	1	558297	1679	287	120	482	80	2648
10		2	612579	894	397	88	760	128	2267
11		3	592499	858	194	101	532	58	1743
12		4	514126	594	107	136	536	148	1521
Total			5726569	9239	2638	1660	4038	648	18223
Percent (%)				50.70%	14.48%	9.11%	22.16%	3.56%	100%

Histogram

Based on the reject histogram of glue (Fig. 3), the types of rejects that occur are product over/under, soap dry damage, wet edge damage, inner box damage, and outer box damage. From a total of 18,223 rejects, under/over products dominate with 9,239 units, followed by inner box damage (4,038 units), soap dry damage (2,638 units), wet edge damage (1,660 units), and outer box damage (648 units). Thus, less/more product rejects are the most common.

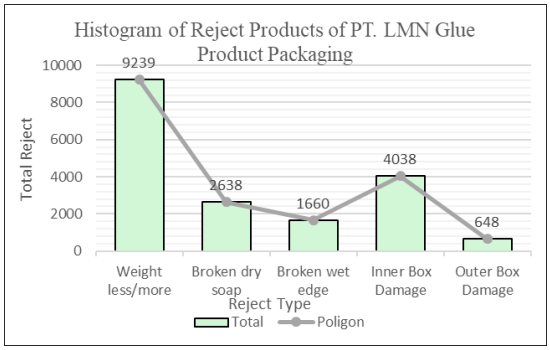

Fig. 3 Data processing with histogram.

Pareto Chart

From the Pareto diagram in Fig. 4, less/more product rejects have a percentage of 50.70%, dry soap damage 14.48%, wet edge damage 9.11%, inner box damage 22.16%, and outer box damage 3.56%. Product rejects are the most common in the production process of glue, with a much higher rate than other rejects.

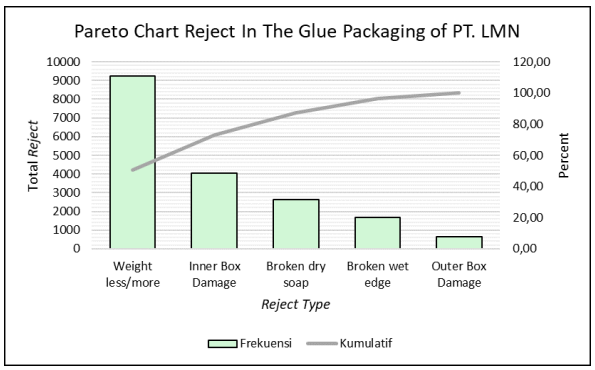

Fig. 4 Data processing with pareto chart.

Scatter Diagram

The scatter diagram (Fig. 5) shows a weak positive correlation (r = 0.302) between production quantity and defects, indicating that reject causes are not solely related to production quantities, and other significant factors need analysis.

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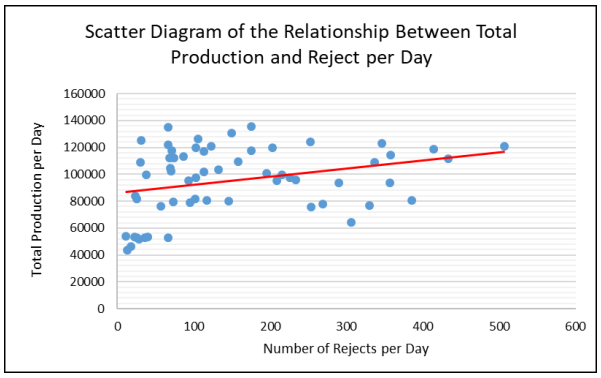

Fig. 5 Data processing with scatter diagram.

Fishbone Diagram

Based on the research, the factors causing reject filling (less/more product weight) in the hopper and filling machine from the man, material, machine, method, measurement, and environment factors are as follows in Fig. 6 and Fig. 7.

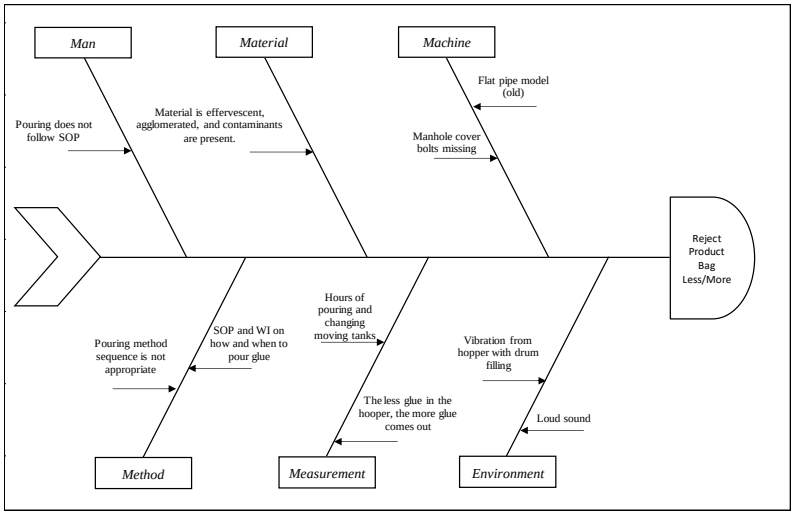

Fig. 6 Data processing with fishbone diagram (hopper).

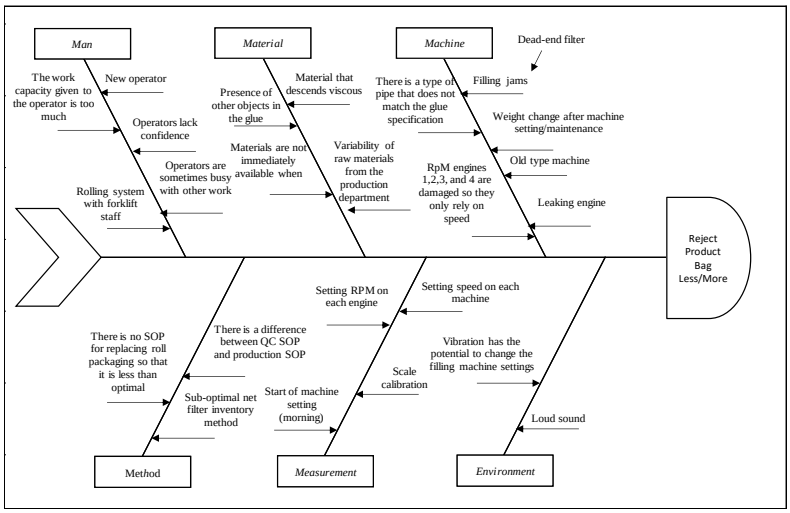

Fig. 7 Data processing with fishbone diagram (filling machine).

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Control Chart

Based on the control chart of reject filling (Fig. 8), there are data outside the control limits, showing a pattern of outliers and significant variation. This indicates changes in the process that may be caused by man, material, machine, method, measurement, and environment factors.

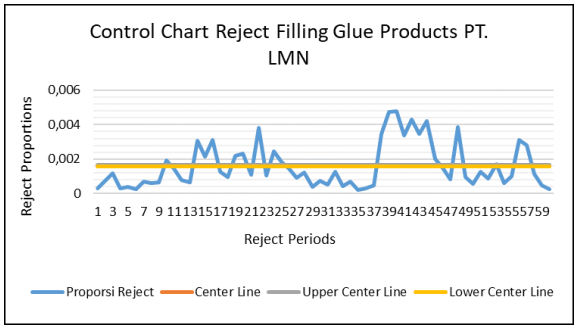


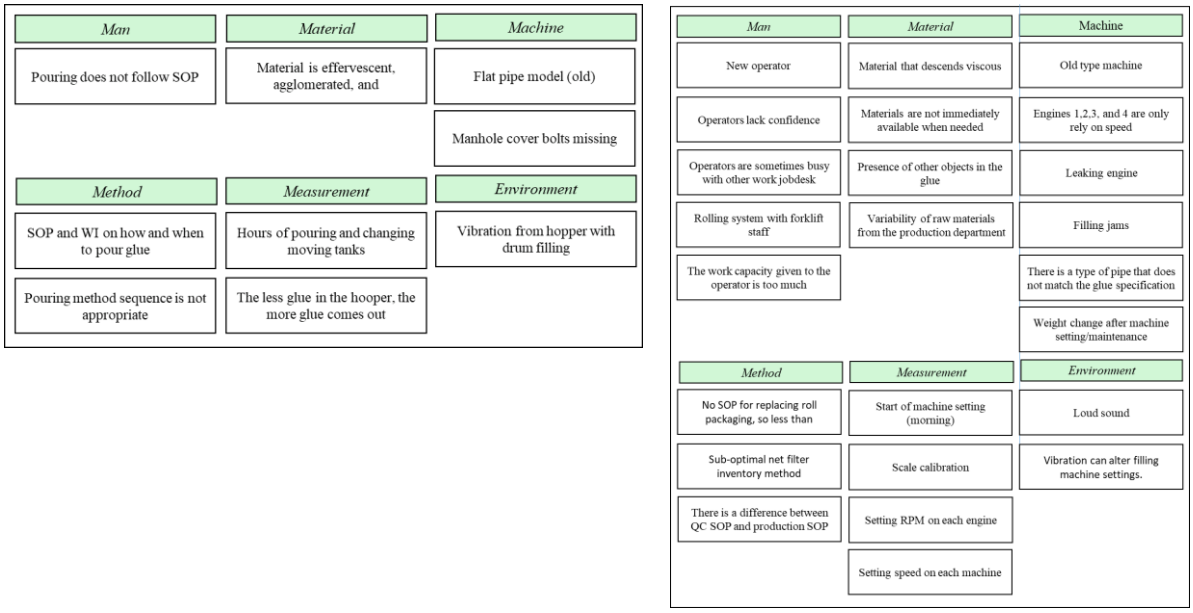
Fig. 8 Data processing with control chart.

3.2 New Seven Tools of Quality Method

The 'New Seven Tools of Quality Control' is a concept that evolved from the 'Seven Basic Tools of Quality,' which is a set of quality management tools used to control and improve quality.

Affinity Diagram

Affinity diagram to analyse the factors causing rejects in the production process of glue displays the factors that cause reject filling. Identification using affinity diagrams is grouped based on the hopper and filling machine because the potential for underweight/overweight products occurs in both parts as show in Fig. 9.



(a) (b)

Fig. 9 Data processing with affinity diagram in hopper (a) and filling machine (b).

Interrelationship Diagram

The interrelationship diagram shows the key factors that cause filling rejects, such as foaming, material clumping, and material contamination with three outgoing arrows for each factor (Fig. 10). In the filling machine (Fig. 11), the main focus is on the defective machine RPM 1-4, which affects the

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speed with three outgoing arrows. The company needs to pay attention to these factors to solve the problem of reject filling (inappropriate product weight).

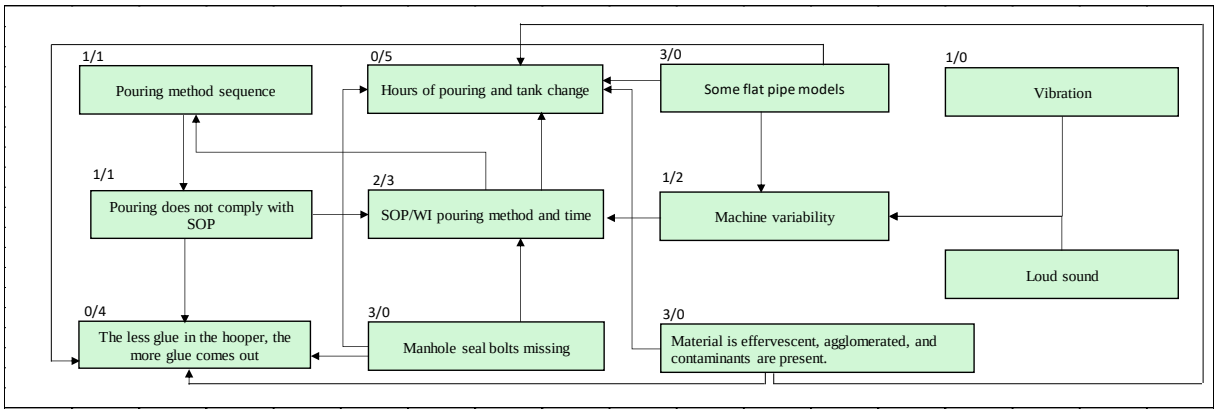

Fig. 10 Data processing with interrelationship diagram (hopper).

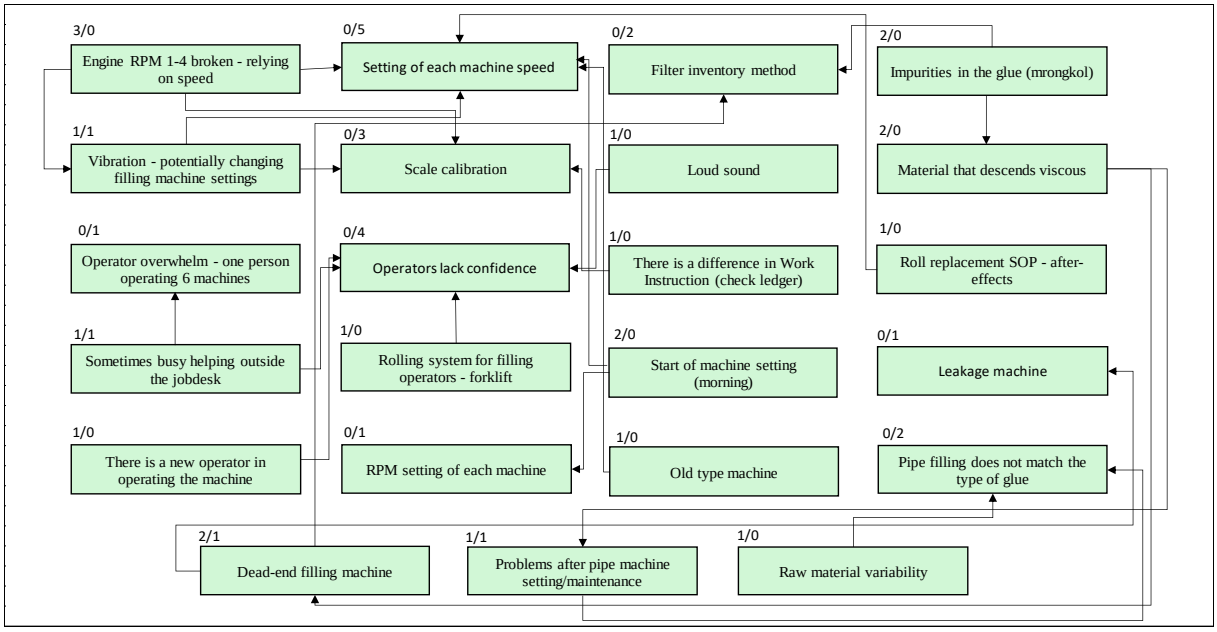

Fig. 11 Data processing with interrelationship diagram (filling machine).

Tree Diagram

To solve the problem of defective glue filling products, a mapping of problems and solutions on 5M + 1E factors has been done. Factors such as Human Performance Improvement, Material, Method, Environment, Measurement, and Machine have been identified to provide solutions. These include intensive training of operators, improved inspection of raw materials, clear implementation of SOPs, creation of comfortable working conditions, improved machine settings and calibration, and regular machine maintenance with adequate spare parts procurement.

Matrix Diagram

Improving operator skills and awareness in improving quality received the highest rating on the man factor. Good material availability and inspection according to the production batch as well as clear announcement of glue type received the highest rating on the material factor. Good machine RPM speed, maintenance routine, and completeness of machine components received the highest rating in the machine factor. Proper work procedures received the highest rating, and a good machine filter inventory method received the second highest rating on the method factor. Well-measured speed and

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RPM received the highest ratings, followed by weighing accuracy in the measurement factor. Comfortable workplace conditions received the highest rating, while vibration within safe limits received the second highest rating on the environment factor.

Matrix Data Analysis

It can be seen that most of the factors causing rejects are in quadrant I (desirable quadrant). However, there are 2 factors that need to be analysed further, namely the factors symbolised by the letters F (Speed and RPM of the machine are running well) and K (Speed and RPM are measured well).

Table 4 Data processing with matrix data analysis

Primary	Secondary	Symbol	Skala 1-10	
			Importance Scale (X)	Company Position (Y)
Man	Improved operator skills	A	7	5
	Operator awareness in improving quality	B	7	9
Material	Good material availability	C	8	7
	Inspection of materials that are in accordance with the production batch	D	6	8
	Announcement of glue type production was well delivered	E	6	7
Machine	Engine speed and RPM are running well	F	9	4
	Machine maintenance routines are performed	G	8	6
	Completeness of machine spare parts	H	5	6
Method	The work procedures implemented are appropriate	I	8	6
	Good machine filter inventory method	J	8	5
Measurement	Speed and RPM are well measured	K	9	4
	Weighing accuracy	L	7	7
Environment	Comfortable workplace conditions	M	8	6
	Vibration within safe limits when pouring drum	N	6	5

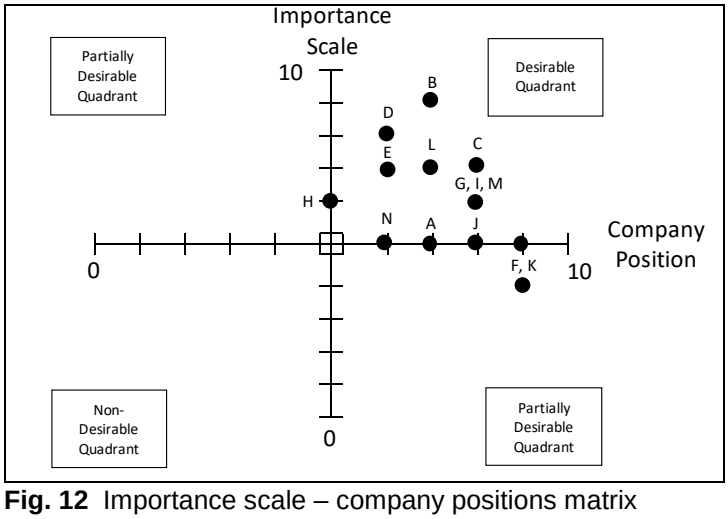

Fig. 12 Importance scale – company positions matrix

Activity Network Diagram

Based on the activity network diagram, the entire packaging process of glue follows a single path which is the critical path. This path is the longest path that must be completed on time to ensure the entire process runs on schedule. Delays in any of the steps on this critical path can cause delays to the entire packaging process. This critical path consists of a sequence of symbols A - B - C - D - E - F - G - H - I - J - K - L - M - N - O.

Process Decision Program Chart

Based on the PDPC above, measures to reduce the number of rejects of glue have been carefully identified. Measures for human performance include maintaining job desks so that operators are experts in one area and providing motivation to improve quality. On the material aspect, strategies

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include ensuring adequate backup stock, using efficient forklift lanes, and improving communication in glue delivery. Continuity of improvement was emphasised in every part of the packaging department by establishing an information system for the type of glue needed. In methods, the implementation of clear SOPs was prioritised along with the addition of machine filters near operators to minimise potential problems. In measurement, machine improvements were made to prevent rejects of non-conforming products, and calibration of scales was done regularly. For machines, there is the implementation of a scheduled maintenance checklist with standardisation and regular updating of components according to machine specifications. Working environment conditions are also considered, with the creation of a device to reduce noise when pouring glue from the drum, as well as regular maintenance of the machine and the use of pads to reduce vibration.

4. Conclusion

The use of seven tools at production department of company identified five types of rejects in the packaging section: reject filling (underweight/overweight), damaged dry soap, damaged wet edge, damaged inner box, and damaged outer box. From January to March 2024, reject filling (underweight) was the highest with 50.70%. New seven tools analyze the causes of reject filling from the aspects of people, raw materials, machines, methods, measurements, and environment. This analysis helps formulate appropriate improvement strategies, improve quality control and operational efficiency, and significantly reduce rejects.

The disadvantage of this study is that the time period used in collecting research data is only three months and suggestions for future research are that researchers can examine and include data on the amount of production and the number of rejected company products with a wider period of time and the possibility of obtaining findings of new reject causal factors that have not been identified to get more valid results and data that are more representative of the company's conditions.

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