Vol. 14, No. 2 (2025): 448 - 457 http://dx.doi.org/10.23960/jtep-l.v14i2.448-457

JURNAL TEKNIK PERTANIAN LAMPUNG

ISSN 2302-559X (print) / 2549-0818 (online)
Journal homepage : https://jurnal.fp.unila.ac.id/index.php/JTP

Quality Control Analysis of Reject Products in the Multiline Machine Packaging Process Using the Statistical Quality Control (SQC) Method

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Article History:

Received : 05 July 2024
Revised : 07 October 2024
Accepted : 22 October 2024

Keywords:

Control chart,
Multiline machines,
Packaging, Reject
Statistical Quality Control (SQC)

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ABSTRACT

Food packaging is used to wrap products in order to protect them from external contamination, including ensuring food safety. Multiline machine is commonly used as the form of packaging. The problem is, the product that is rejected is often surpass the standard limits that has been set by the company. This study aims to identify the types of rejects that often occur, identify rejects that are still within the control limits or not and what factors cause reject products. Statistical Quality Control (SQC) method with seven control tools is used within this research. The study concludes there were 6 types of rejects produced by the multiline machine. 3 of the highest rejects types on the pareto diagram of the multiline machine, namely leaking as many as 5,550 sachets for percentage of 28.16%, reject cutter as many as 4,760 sachets for percentage of 24.21% and packaging precision as many as 4,180 sachets for percentage of 21.21% with a cumulative percentage of 73.52%. After being revised, the results of the reject control chart analysis are still within the control limits, but still with high amounts of rejects. Materials, machines, people, and methods are the factors that affect products to be rejected.

1. INTRODUCTION

Competition in the global era requires companies to maintain the quality of their products. Efforts can be made to maintain market confidence both in terms of quality and quantity, by guaranteeing certified products such as the Halal Product Guarantee Organization (BPJPH), ISO 22000, the Food and Drug Supervisory Agency (BPOM). Companies are required to keep up with all developments and continue to produce new products, so that the company can survive against competitors. Each product packaging includes how to serve, nutritional value information, composition, production code, customer service, and barcode on each product. Product packaging generally uses Polyethylene Teraphthalate (PET) plastic with aluminum foil inside. During the production process cannot be separated from problems or reject products. Reject products are products resulting from the production process that do not meet the quality standards produced. Every company has quality standards for all its products (Arianti *et al*., 2020; Wahyuati, 2016; Ramadhany & Supriono, 2017). These standard are used to ensure that consumer expectations match the quality of the products produced. There are various types of rejects produced from multiline machines, namely setting, cutter, joint, packaging precision, production code, and leak inspection. Every company has a target of reject packaging on all its products to reduce losses.

One effort is to use a quality control system. Quality control is needed because even though the production processes have been carried out properly, in reality there are still problems, namely there are discrepancies or reject products. Damage or rejects on the product certainly affect the final quality of the product, if not controlled, the company will not be able to compete with its competitors, therefore quality control needs to be applied to reject products (Alhumairoh, 2021; Alifka & Apriliani, 2024).

Statistical Quality Control (SQC) is an appropriate statistical tool to reduce rejected products. SQC output has a wide scope, where problem solving covers 2 things, namely exceeding the control limit if the process is out of control and not exceeding the control limit if the process is in control. Quality control using SQC needs to be used in order to find out reject products and make the right decisions so that product quality is maintained so that rejects can be minimized. The purpose of this study is to determine the value and type of rejects that commonly occur, to know the number of rejects produced is still within the control limits and to identify the factors that cause the product to be rejected. This research is expected to be taken into consideration by the company as well as relevant recommendations for improvement so as to realize a controlled production process and produce low reject products.

2. RESEARCH METHODOLOGY

The research was conducted at PT X which is a company engaged in the production of food and beverages. Data collection is done through direct observation, documentation data from the company, and interviews. The research was conducted for 21 days in December 2023, according to working hours at PT X. Working hours at PT X with a shift system according to the Production, Engineering and Quality Control (QC) Departments. There were 3 shifts with a total of 8 working hours from Monday to Friday and 5 working hours on Saturday with a 45-minute break. Based on the findings of the factor analysis the resulting output is a recommendation to reduce rejects.

Identification was done in several stages, namely: (1) preliminary stage by making direct observations to identify problems such as types of rejects, (2) factors that cause rejects, (3) literature study. Data was obtained in the form of primary data and secondary data. Primary data is obtained by making direct observations every hour to find out the types of rejects and the amount produced in the packaging process on the multiline machine and folding machine 18 because the machine often experienced errors in several engine components. Secondary data was conducted through interviews and documentation. The data was processed using the Statistical Quality Control (SQC) method to determine the number of rejects generated in the packaging process whether it was still within the control limits or not. Data analysis was conducted using stratification, check sheets, histograms, Pareto diagrams, scatter diagrams, control chart, and fishbone diagrams.

2.1. Check Sheet

Check sheets also known as inspection sheets are data collection and analysis tools presented in the form of a table containing the amount of production, the type of non-conformity and the number of results. Its purpose is to facilitate the data collection or analysis process.

2.2. Histogram

Histogram is a data presentation tool that displays the distribution of values in numbers in the form of a bar graph (Akbar *et al*., 2023; Putra & Sumiati, 2023). Histograms are useful because they can provide information about variations in the process and assist management in making decisions.

2.3. Pareto Diagram

Pareto diagram is a bar graph that shows problems in order of the number of occurrences. The order starts from the number of problems that occur the most to the least. This pareto diagram helps determine which problems should be solved. The problems that occur most often are the top priorities for taking quality control actions (Subhan, 2022; Saefullah *et al*., 2023).

2.4. Control Chart

Control chart is a control map that describes quality improvement (Haryanto, 2019; Hairiyah *et al*., 2019). In addition, the control map also functions as a statistical map or graph that explains whether the activity or process has the quality control of a process under control or not under control. The elements in the control map are Center Line (CL), Upper Control Line (UCL) and Lower Control Line (LCL). The control chart used in this study is a type of attribute control chart, using a scale of the proportion of damage or defects. Control map is one type of attribute limit control chart with data on the results of defects or products that have non-conforming results. Calculations for making control charts are as follows:

$$CL \quad = \bar{P} = \frac{\sum_{i=1}^{m} pi}{m} \tag{1}$$

$$UCL \quad = \bar{P} + 3\frac{\sqrt{\bar{P}(1-\bar{P})}}{n} \tag{2}$$

$$LCL \quad = \bar{P} - 3\frac{\sqrt{\bar{P}(1-\bar{P})}}{n} \tag{3}$$

where pi is number of defective products, $\bar{P}$ is the center line of the control map of the proportion of defects, m is number of observations made, n is number of defective products.

2.5. Fishbone

This diagram is useful for analyzing determining the quality characteristics of the output of a process. It is useful for finding the true source of a problem. The only tool that presents qualitative data is the fishbone diagram. This tool helps to illustrate the condition of quality deviations that are influenced by several interconnected factors. The fishbone diagram is useful for showing the main factors that affect quality and have an effect on the problem we are studying, besides this diagram allows us to see more detailed factors that influence and affect the main factors. There are 5 main factors that cause a problem, namely:

1. Manpower: problems originating from human resource factors such as skills, tenacity, thoroughness and skills possessed.
2. Machine: problems originating from machines such as machine condition, machine age, damaged machine components and machine condition.
3. Method: is a method used in carrying out work or operating machinery and equipment. The mismatch of methods will cause deviations and problems.
4. Material: problems originating from materials such as the quality of the material used is not suitable or not uniform which can cause problems.
5. Environment: problems originating from the environment such as conditions, time, temperature and work culture.

3. RESULTS AND DISCUSSION

Based on the research that has been conducted, data on production realization and total rejects generated in the powder beverage packaging process using a multiline machine at PT X were obtained. This research was conducted by differentiating the types of rejects produced on each machine. Working hours also affect production realization and total rejects. The results of the study can be seen from the data in Table 1, the highest reject data is on Wednesday (December 27, 2023) amounting to 3.1%, this is due to damage to one of the cutter components, namely the connecting bolt is not tight enough so that the cutter cutter 10 does not rotate back after cutting or stak and the etiquette used is less support on the multiline machine 18 resulting in low production realization and the resulting total reject is high, possibly also due to the first day of production after the machine is off for 3 days so it has to reset. The types of rejects as listed in Table 2 are described in detail in Table 3.

3.1. Check Sheet

A check sheet also known as a check sheet is a tool for collecting and analyzing data presented in the form of a table containing the number of items produced, the type of reject and the amount produced (Asma, 2022). This check sheet is useful to simplify the process of collecting data for analysis.

Table 1. Collected data

Day	Date	Shift	Total Reject (Sachet)	Production realization (Sachet)	Total Reject (%)
Tuesday	5 Desember 2023	2/G	800	126,720	0.63
Wednesday	6 Desember 2023	2/G	210	95,760	0.22
Thursday	7 Desember 2023	2/G	300	136,080	0.22
Friday	8 Desember 2023	2/G	260	123120	0.21
Saturday	9 Desember 2023	2/G	60	75,600	0.08
Monday	11 Desember 2023	1/G	820	77,040	1.06
Tuesday	12 Desember 2023	1/G	480	96,480	0.50
Wednesday	13 Desember 2023	1/G	1,140	99,360	1.15
Thursday	14 Desember 2023	1/G	560	99,360	0.56
Friday	15 Desember 2023	1/G	720	118,800	0.61
Saturday	16 Desember 2023	1/G	1,400	69,840	2.00
Monday	18 Desember 2023	1/H	320	100,800	0.32
Tuesday	19 Desember 2023	1/H	650	60,480	1.07
Wednesday	20 Desember 2023	1/H	2,590	113,040	2.29
Thursday	21 Desember 2023	1/H	1,020	72,000	1.42
Friday	22 Desember 2023	1/H	590	123,120	0.48
Saturday	23 Desember 2023	1/H	1,510	57,600	2.62
Wednesday	27 Desember 2023	1/H	3,600	117,360	3.07
Thursday	28 Desember 2023	1/H	240	121,680	0.20
Friday	29 Desember 2023	1/H	2,360	125,280	1.88
Saturday	30 Desember 2023	1/H	80	74,880	0.11
Total			19,710	208,4400	20.70
Average			938.57	99,257.14	0.98

Table 2. Check Sheet Data

Data to	Production quantity	Reject Type (Sachet)						Total Rejects
		Setting	Cutter	Connection	Packaging precision	Code Production	Leaking	
1	127,650	640	160	0	0	0	0	800
2	96,030	30	120	60	0	0	0	210
3	136,400	120	0	180	0	0	0	300
4	123,550	140	60	60	0	0	0	260
5	75,960	60	0	0	0	0	0	60
6	77,930	90	610	120	0	0	0	820
7	97,090	60	0	0	0	0	420	480
8	100,580	120	0	60	0	340	620	1,140
9	99,940	0	340	60	0	0	160	560
10	119,760	720	0	0	0	0	0	720
11	71,320	280	0	120	0	1,000	0	1,400
12	101,290	60	200	60	0	0	0	320
13	61,440	0	120	60	470	0	0	650
14	115,740	10	60	0	240	90	2,190	2,590
15	73,320	30	130	180	680	0	0	1,020
16	123,750	60	470	60	0	0	0	590
17	59,230	90	900	0	520	0	0	1,510
18	120,990	30	1,390	60	160	0	1,960	3,600
19	122,040	0	120	120	0	0	0	240
20	127,710	50	0	0	2,110	0	200	2,360
21	74,970	0	80	0	0	0	0	80
Total	**2,106,690**	**2,590**	**4,760**	**1,200**	**4,180**	**1,430**	**5,550**	**19,710**

Table 3. Reject identification

Reject Code	Reject Condition	Reject identification
A	**Setting**	
	Initial settings	Monday production start, shift change
	Running settings	Improper packaging cutter
	Change etiquette	Change packaging material
	Sealer is too hot	Sealer is too hot
	Sealer does not stick	Sealer does not adhere so the package is open
B	**Cutter**	
	Cutter error	Cutter does not rotate back
	Cutter is not suitable	Packaging is easy to break, pieces are not suitable
C	**Connection**	Joints in the etiquette roll (packaging material) filled with product powder
D	**Packaging Precision**	Sealer seals not in the actual area
E	**Production Code**	
	Unreadable production code	No expiration, not clear
	Monitoring UV laser Fault expiration	There is a line that makes
F	**Leaking**	
	A1	Leaking Vertical Horizontal
	A2	Leaking Expired

The results showed that there were a total of 2,106,690 sachets and the total rejects produced by the multiline machine were 19,710 sachets. The highest reject with a total of 3,600 sachets in the 18th data is due to the connecting bolt being less tight so that the cutter does not rotate back after cutting, besides that due to leaks which may be less supportive etiquette on the multiline machine 18. The lowest reject is 60 sachets in the 5th data because the machine is running well and the etiquette supports the machine. The highest type of reject produced by the multiline machine is leakage reject on the 14th data because there were 2 horizontal leaks on line 2 and line 6 so that it reached 2,190 sachets. This leakage was caused by a dirty horizontal sealer which resulted in a lack of pressure on the product packaging and etiquette lack of support on the machine.

3.2. Histogram

After the cheek sheet is made, then a histogram is made with the aim of showing the type of product damage that occurs most. Histogram diagram is a data presentation tool in the form of a beam graph (Nazia *et al*., 2023; Zecky & Riandadari, 2018). The results of the multiline machine histogram diagram can be seen in Figure 1 where the horizontal axis shows the type of reject, while the vertical axis shows the total reject. The highest type of reject is leakage reject with a red chart of 5,550 sachets, followed by cutter reject with a light blue chart of 4,760 sachets and precision packaging reject with a dark blue chart of 4,180 sachets. The lowest type of reject is the joint with a yellow chart of 1,200 sachets.

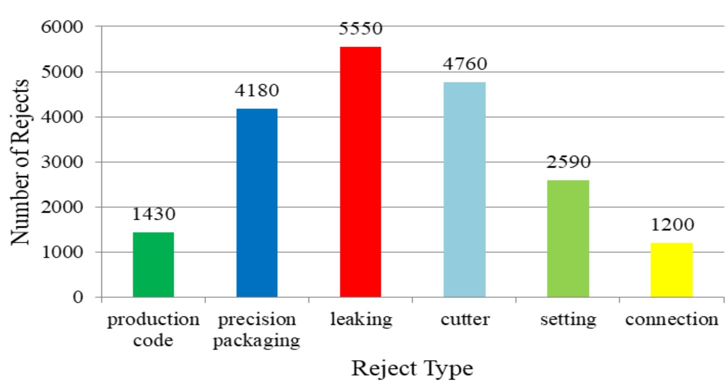
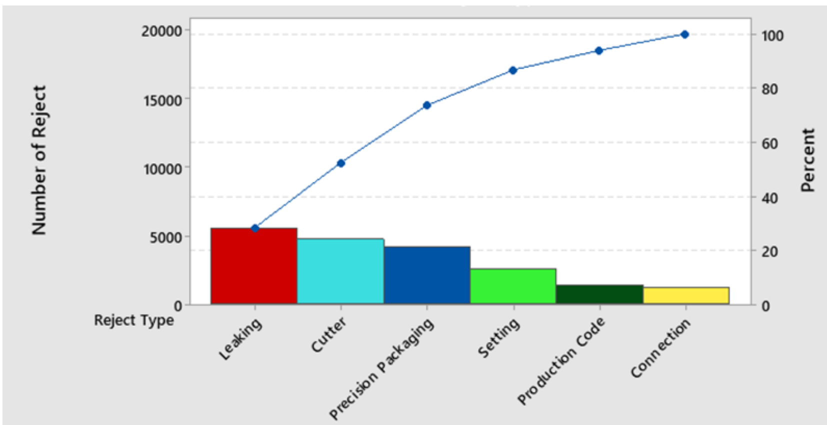


Figure 1. Histogram diagram

3.3. Diagram Pareto

A pareto diagram is a bar graph that shows problems based on the order of the number of occurrences, starting from the problems that occur the most to the least (Carmelita, 2022). How to make this pareto diagram by sorting each type of reject from the largest and smallest order, then calculating the percentage of defects and the cumulative percentage of each type of reject. Based on the results of the analysis, the most dominant type of reject is reject leak with a percentage of 28.2%, then reject cutter with a percentage of 24.15% and reject packaging precision with a percentage of 21.21%. Of the three percentages, the total is 73.52%. The pareto principle says the 80/20 rule, that 80% of quality problems are caused by 20% of the causes of defects, so the types of defects that have a cumulative percentage of 80% are selected with the assumption that the 80% represents all types of defects that occur (Gunawan & Tannady, 2016). So from the results of this analysis, the problem is solved by overcoming the cumulative percentage which is close to 80%, namely reject leaks, cutters and packaging precision, so as to reduce the number of rejects on the product, improvements are made by focusing on the largest types of rejects.



	Leaking	Cutter	Precision Packaging	Setting	Production Code	Connection
Number of Reject	5550	4760	4180	2590	1430	1200
Percent	28,2	24,2	21,2	13,1	7,3	6,1
Cum %	28,2	52,3	73,5	86,7	93,9	100,0

Figure 2. Pareto diagram of reject types

3.4. Control Chart

Control charts are used to determine whether the rejects produced are still within the control limits or outside the statistical control limits or not (Firdaus, 2023; Putra & Puspitasari, 2022). Aiming to find out what is the maximum proportion of reject products per day to stay within the control limits, so that with the use of this control map, handling can be done on the problems that arise. The control map used is the P attribute control map because the samples used for this study vary every day. Based on the p control chart graph in Figure 3, the multiline machine reject variable is outside the control limits with a UCL value of 0.00607 and LCL of 0.00448. This shows that the control limit line which may be too narrow can cause the observed data to be statistically uncontrolled. The pattern of points on the P control map shows fluctuating points that form an out of control pattern. This deviation identifies that during the production or packaging process of powdered drinks there are still problems resulting in many rejected products, because of the large amount of uncontrolled data, it is necessary to test the data with a diagnostic p chart to determine whether the data is overdispersion or not (Ramadhani & Liquiddanu, 2022).

The diagnostic P chart results in Figure 4 of this diagnosis line found that over dispersion is caused by excessive data spread. Over dispersion can cause the traditional P chart to produce narrow UCL and LCL control limits, so the data looks abnormal and exceeds the limits, even though it is not. The data variation is 326.3% and the confidence limit is 157.3%, if the resulting variation value is greater than the confidence limit, it indicates that the data is over dispersed (Rachmawati, 2023; Ginting, 2023). The resulting data experiencing over dispersion shows false alarm results so it is recommended to use the Laney P control chart.

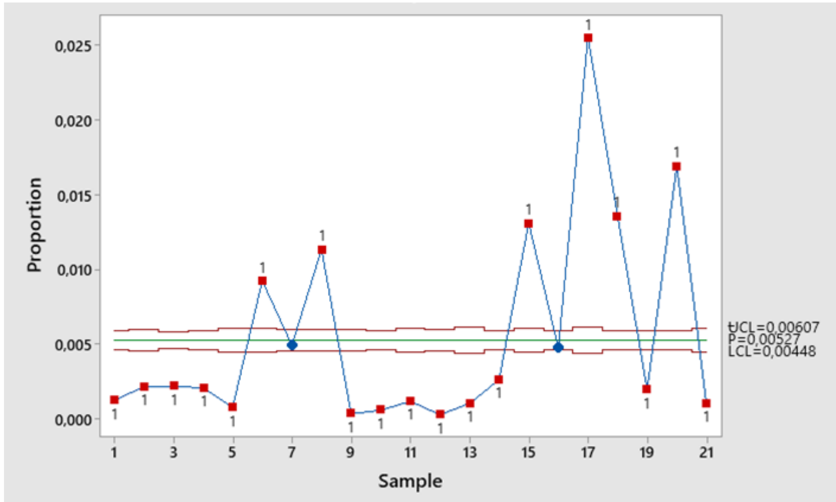


Figure 3. P chart control for total reject of multiline machine

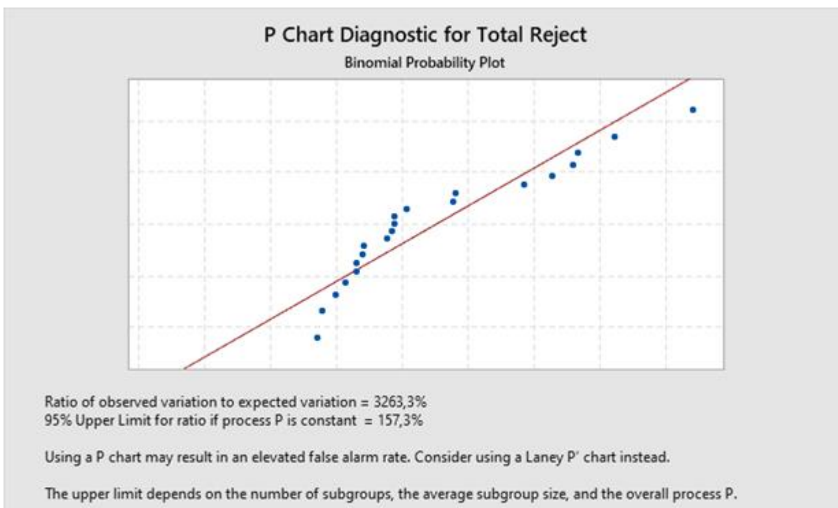


Figure 4. P chart diagnostic for total reject

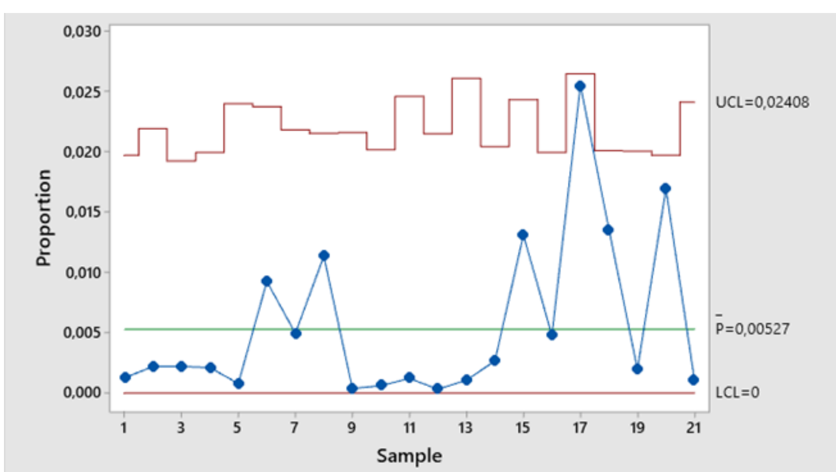


Figure 5. Laney P' chart for total reject (Sigma Z =23.7053, tests were performed with unequal sample sizes)

Laney P' is used for large and variable sample sizes because the control limits of the Laney P' chart are larger the results are more rational. Figure 5 shows that the sigma Z value is 23.7053. Sigma z is used to determine whether the data is overdispersed, normal or underdispersed. Data is said to be overdispersed if the sigma Z value <1, if the sigma Z value = 0 then the data is considered normal or abnormal so that adjustment needs to be done. Data is underdispersed if the sigma Z value <1 (Rachmawati, 2023). The results of the laney P' chart plotting analysis state that 21 data are on the control limit even though the process can be said to be under control, but the reject data is unstable sometimes experiencing a significant increase in defects such as in the 17th data.

3.5. Fishbone Diagram

Fishbone diagrams are used to identify and analyze what factors cause product defects (Aristriyana & Fauzi, 2022). One of the causes or influences of damage to the product is generally, namely, humans, materials, machines and methods. Based on the Pareto diagram that has been made, it has the principle of 80% of the results of problems that arise based on 20% of the causal factors, so this Fishbone diagram focuses on one of the largest types of rejects, namely leaking.

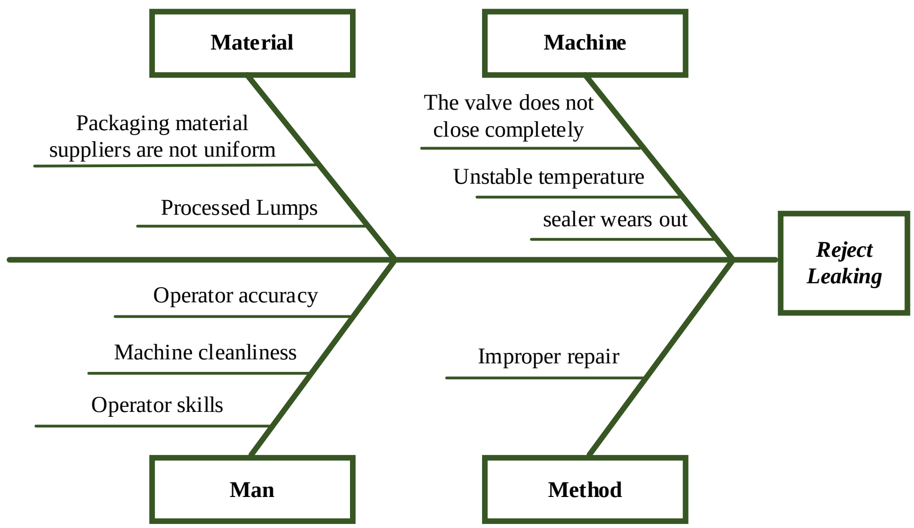


Figure 6. Fishbone diagram

1. Material

Packaging materials or etiquettes come from several different suppliers. These different suppliers certainly have different compositions, constituent materials and manufacturing temperatures. These supplier differences also affect the resulting output, because the machine has properties that not all auxiliary materials support the machine. Clumping usually occurs because the moving hopper is still slightly wet or the moisture content of the processed material is high. Processed lumps can inhibit valve performance.

2. Machine

Valves are not perfectly closed, processed products or powders certainly have different mesh sizes, because they are obtained from different suppliers. The inequality of the mesh size can result in processed clumps so that the powder falls first and is exposed to the horizontal sealer (timming). Unstable temperature or the rise and fall of the sealer temperature results in product leaks, the sealing ability cannot be maximized because the temperature rises and falls suddenly. The rise and fall of the sealer temperature is due to dirty carbon brushes exposed to powder that flies into the sidelines of the machine. Worn sealers are seen to lose some ornaments so that they cannot seal or seal optimally, causing the resulting output to leak. Machine age and continuous use can cause the sealer to get thinner. The handling that operators usually use in the meantime is to patch the sealer area with packaging material.

3. Man

Operators are responsible for operations and output. Operator negligence can affect the occurrence of reject products. If the operator is careful, it will not be too late to find out the problems that exist in the machine. Lack of sealer cleanliness also causes high rejects. Keeping the machine clean will minimize repairs. Low operator awareness can cause leaks due to dirty sealers due to melted packaging material (aluminum foil). So that horizontal and vertical sealers must be cleaned regularly, because this dirty sealer is one of the causes of leakage because it inhibits heat so that the sealing process does not seal perfectly. Each operator always has different skills in operating the machine. The difference in operator skills can be influenced by the ability, expertise, duration of work and training he participates in. The better the ability to operate the machine, the less rejects produced.

4. Method

Improper repair or misidentification results in failure reoccurrence as the cause is not properly resolved. When a leak is found by the QC, most operators will clean the sealer area and tap the funnel former to remove any powder stuck to the funnel. If the leak is caused by cracking or sealer wear, what is done is to ensure the sealer pressure is not too tight and even to overcome cracking. Meanwhile, the handling of worn sealers is to increase the area that is considered worn and causes leakage.

4. CONCLUSION

1. Based on the research that has been done multiline machine rejects there are 6 types of rejects namely setting, Cutter, Connection, Packaging precision, Production code and Leaking, but based on pareto diagram analysis there are 3 types of rejects that are more dominant. Reject with the highest value on the multiline machine is the leak type reject of 5,550 sachets.
2. The results of the revised control map analysis on the multiline machine produced nothing outside the control limits or rejects are still in control, but on the multiline machine there are 4 data that are still high, namely on the 15th, 17th, 18th and 20th day data. Based on the analysis of the fishbone diagram, rejects are generated by several main factors, namely materials, machines, people and methods.
3. Factors from materials, namely raw materials or packaging materials produced from several suppliers. Machine factors such as sensors that do not read quickly, cutters, unstable temperatures and machine speed. Human factors that affect operator accuracy and skills. Factors of improper repair methods and less rapid action.

Based on results of this research, it is suggested the implementation of machine maintenance is started from the largest component to the smallest component can prevent damage or repair within a certain period of time so that the production process is not interrupted. Regular operator training to improve skills, operator competence and provide standard operating instructions on machines that are easily accessible are very important. The need to implement regular machine condition checks when the machine is not operating, when the machine is operating and after operation, especially on sensors, sealers and cleanliness can reduce rejects or failures.

ACKNOWLEDGMENTS

The author would like to thank the company for allowing the author to conduct research.

REFERENCES

Akbar, M., Wahyudin., & Khoirulloh, A. (2023). Analisis tingkat kecacatan kemasan produk dengan menggunakan metode seven tools di PT. ABC. *Journal of Industrial Engineering and Operation Management (JIEOM)*, ***6***(1), 18-26. http://dx.doi.org/10.31602/jieom.v6i1.9593

Alifka, K.P., & Apriliani, F. (2024). Analisis pengendalian kualitas produk menggunakan metode statistical process control (SPC) dan failure mode and effect analysis (FMEA). *Factory Jurnal Industri, Manajemen dan Rekayasa Sistem Industri*, ***2***(3), 97–118. https://doi.org/10.56211/factory.v2i3.486

Alhumairoh, F.N. (2021). Analisis Produk Reject Terhadap Pengendalian Kualitas Menggunakan Metode Statistical Process Control Di PT. X. [*Undergraduated Thesis*], Politeknik Negeri Jakarta.

Arianti, M.S., Rahmawati, E., & Prihatiningrum, R.R.Y. (2020). Analisis pengendalian kualitas produk dengan menggunakan statistical quality control (SQC) pada usaha Amplang Karya Bahari di Samarinda. *Jurnal Bisnis dan Pembangunan*, ***9***(2), 1-13.

Aristriyana, E., & Fauzi, R.A. (2022). Analisis penyebab kecacatan produk dengan metode fishbone diagram dan failure mode effect analysis (FMEA) pada Perusahaan Elang Mas Sindang Kasih Ciamis. *Jurnal Industrial Galuh*, ***4***(2), 75–85. https://doi.org/10.25157/jig.v4i2.3021

Asma, K. (2023). Analisis statistical quality control (SQC) pada produksi roti di Mahkota Bakery. [*Undergraduated Thesis*]. Program Studi Teknik Industri, Institut Teknologi Nasional Malang.

Carmelita, F. (2022). Analisis pengendalian kualitas pada produk spatula alumunium di Pekanbaru. [*Undergraduated Thesis*]. Program Studi Manajemen, Fakultas Ekonomi dan Bisnis, Universitas Islam Riau.

Firdaus, A.R. (2023). Analisis pengendalian kualitas produk cuka apel dengan metode P-Chart di PT. Tirta Sarana Sukses. [*Intership Report*]. Program Studi Teknologi Rekayasa Pangan, Jurusan Teknologi Pertanian, Politeknik Negeri Jember.

Ginting, M.I.D. (2023). Penerapan Metode Six Sigma dan Failure Mode And Effect Analysis (FMEA) dalam Meminimasi Terjadinya Defect Pada Proses Produksi (Studi Kasus Di PT . Sandang Asia Maju Abadi). [*Undergraduate Thesis*]. Faculty of Industrial Technology, Universitas Islam Indonesia, Yogyakarta: 62 p.

Gunawan, C.V., & Tannady, H. (2016). Analisis kinerja proses dan identifikasi cacat dominan pada pembuatan bag dengan metode statistical proses control (Studi kasus : Pabrik alat kesehatan PT.XYZ, Serang, Banten). *Jurnal Teknik Industri*, ***11***(1). https://doi.org/10.12777/jati.11.1.9-14

Hairiyah, N., Amalia, R.R., & Luliyanti, E. (2019). Analisis statistical quality control (SQC) pada produksi roti di Aremania Bakery. *Industria: Jurnal Teknologi dan Manajemen Agroindustri*, ***8***(1), 41–48 https://doi.org/10.21776/ub.industria.2019.008.01.5

Haryanto, I.I.S. (2019). Penerapan metode SQC (statistical quality control) untuk mengetahui kecacatan produk shuttlecock pada UD. Ardiel Shuttlecock. *Jurnal Valtech*, ***2***(2), 186-191.

Nazia, S., Fuad, M., & Safrizal. (2023). Analisis statistical quality control (SQC) dalam pengendalian kualitas produk pada usaha batu bata di Kota Langsa. *Jurnal Minfo Polgan*, 12(1). https://doi.org/10.33395/jmp.v12i1.12790

Putra, I.D.G.R, & Sumiati, S. (2023). Analisis tingkat kecacatan produk dengan seven tools dan failure mode effect analysis di PT. Selatan Jadi Jaya. *Jurnal Penelitian Rumpun Ilmu Teknik*, ***3***(1), 198–209. https://doi.org/10.55606/juprit.v3i1.3236

Putra, G.D., Pangestu, P.A., & Puspitasari, I. (2022). Analisis pengendalian kualitas produk dengan menggunakan analisis P-Chart untuk mengetahui penyebab produk rusak di PT. Krakatau Steel. *Bulletin of Applied Industrial Engineering Theory*, ***3***(1), 7–10.

Rachmawati, A. (2023). Penerapan metode six sigma dan FMEA sebagai upaya minimasi defect proses pengemasan di PT. Marimas Putera Kencana. [*Undergraduated Thesis*]. Program Studi Teknologi Rekayasa Pangan, Jurusan Teknologi Pertanian, Politeknik Negeri Jember.

Ramadhani, D.D., & Liquiddanu, E. (2022). Perbaikan kualitas produk KKBW 480 menggunakan metode six sigma di PT. INKA (Persero). *Jurnal Seminar dan Konferensi Nasional IDEC*, 23 Juli 2022: D10.1- D10.10.

Ramadhany, F.F., & Supriono, S. (2017). Analisis penerapan sistem manajemen mutu ISO 9001:2015 dalam menunjang pemasaran (Studi pada PT Tritama Bina Karya Malang). *Jurnal Administrasi Bisnis* (*JAB*), ***53***(1), 31–38.

Saefullah, A., Fadli, A., Nuryahati, N., Agustina, I., & Abas, F. (2023). Implementasi prinsip Pareto dan penentuan biaya Usaha Seblak Naha Rindu. *Jurnal Media Wahana Ekonomika*, ***20***(1), 1–13. https://doi.org/10.31851/jmwe.v20i1.11077

Subhan, A. (2022). Penerapan Metode Seven Tools of Quality Control dalam Mengurangi Irregularity Cargo pada Pos Operasional Cargo Export PT. Gapura Angkasa Cabang Denpasar. [*Undergraduated Thesis*]. Jurusan Administrasi Niaga, Politeknik Negeri Bali.

Wahyuati, A. (2016). Pentingnya standar di dalam dunia usaha. *EKUITAS (Jurnal Ekonomi dan Keuangan)*, ***1***(1), 38-44.

Zecky, V.M., & Riandadari, D. (2018). Penerapan setode Statistical Quality Control (SQC) dalam meminimalisir cacat produk paving block K300 – T6 di PT. Ase Gresik. *Jurnal Pendidikan Teknik Mesin*, ***06***(3), 86–92.