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Quality Control of Janggelan Products Using Statistical Quality Control (SQC) and Failure Mode Effect Analysis (FMEA) Methods in UD. Rizqi Agung

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A B S T R A C T

UD. Rizqi Agung is one of the SMEs in Ngrayun, Ponorogo. This SMEs is one of the medium-sized SMEs that produces packaged drinks. The packaged drinks produced are drinks made from janggelan juice. UD. Rizqi Agung has a production process that is still semi-manual so that there are still products that still have defects in these products. The methods used are Statistical Quality Control (SQC) and Failure Mode and Effect Analysis (FMEA). SQC tools are check sheet, stratification, histogram, paretto diagram, scatter diagram, control chart, and cause and effect diagram. While FMEA is used for improvement of the results of the cause and effect diagram. Based on the results of research on Sari Janggelan products, the most dominant defect is obtained, namely Cup Dent defects (4.06%), followed by Leak defects (2.84%), Dented Cardboard defects (1.30%), and Label not Symetric defects (1.22%). Proposed improvements with FMEA obtained risks that have the highest priority level to make improvements to minimize the possibility of errors. The highest RPN values is 320 and 288 of the type of cup dent defect with proposed improvement recommendations, namely changing cup vendors to match the quality requested by SMEs and monitoring employee performance.

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1. INTRODUCTION

In the current era, public awareness of the difficulty of finding employment encourages some people to create their own jobs. With capital that can be said to be relatively small, they can establish a business with a small to medium production capacity, which is usually called SMEs. SMEs stands for Micro, Small and Medium Enterprises. So that in the current era we find a lot of SMEs among people who have a product. Free competition at this time causes every SME's to be able to create products with the best specifications so that customer satisfaction can be met. UD. Rizqi Agung is one of the SME's in Ngrayun District, Ponorogo. This SME's is one of the medium-sized SME's that produces packaged drinks. The packaged drinks produced are drinks made from

janggelan juice. The phenomenon that occurs at UD. Rizqi Agung is the process of making this drink is still semi-manual so that there are still products that still have defects in these products. In this case UD. Rizqi Agung has a goal to generate optimal profits by increasing efficiency and minimizing defects in its products.

The problem faced by this factory is the defects in its products. The types of product defects are cup dents, leaks, asymmetrical label, and dented cardboard. In janggelan juice beverage products, the number of defects is known to be an average of 9.4%. With this UD. Rizqi Agung wants to improve its products to control defects in its products in an effort to increase productivity and increase profits for the factory and reduce product defects. This research uses the Statistical Quality Control (SQC) method used to control quality from the initial process to the finished product and Failure Mode And Effects Analysis (FMEA) used to identify and prevent problems that occur in products and processes.

2. LITERATURE REVIEW

Quality is the most fundamental factor for customer satisfaction. When a company produces a product, of course, it must pay attention to quality in order to achieve the company's desire to satisfy customers. To produce quality products from raw materials, the production process to the actual product, product quality is one of the main objectives of the company. A product has quality if it complies with predetermined quality standards. In today's development, companies must always have innovations to improve their efficiency, effectiveness, and performance in order to compete with others (Andespa, 2020).Companies that produce these products should pay attention to the quality of their products and follow the criteria and rules to determine whether the products to be produced are of good quality or the products do not meet the requirements / defective / non-conforming. Defective products are products that are not optimal in the manufacturing process or do not meet the company's quality standards. Defective products can be repaired economically by adding certain costs, which will expose the company to higher costs and losses due to uncontrolled defective products. (Andespa, 2020).

Statistical quality control can be done using statistical quality control (SQC). According to Assauri (2004), statistical quality control is a system used to maintain production quality standards at minimum cost and is a tool to achieve efficiency. According to Cawley and Harrold (1999) in Rachman (2012), Statistical Quality Control (SQC) or Statistical Quality Control is a problem-solving technique through monitoring, control, analysis, management and improvement of products and processes with statistical methods. Statistical quality control is often referred to as statistical process control (SPC). Statistical Quality Control (SQC) has been widely recognized as an effective approach to monitoring manufacturing and service processes with respect to the use of variables or attribute charts in specific processes (Saka et al., 2019). The advantage of the SQC method is that it works based on objective data/facts, not subjective opinions. SQC management can track quality metrics of integrated manufacturing processes from upstream/suppliers/raw materials to downstream/customers/finished products so that management decisions are completely accurate based on the analysis and processing of various existing data. SQC has the ability to account for anomalies in the process and check if the process is growing/declining so that corrective and preventive actions can be taken before problems actually occur. SQC works effectively in areas where the manufacturing process takes place immediately, allowing product deviations to be avoided as early as possible (Manik, 2020).

Failure Mode Effect Analysis (FMEA) is a structured process to identify and prevent as many failure patterns as possible. FMEA is a system reliability assessment technique to determine the impact of system failures. These failures are classified according to their effect on the success of the system mission. (Erwindasari, 2019).Failure Mode Effect Analysis (FMEA) is used to identify the source and root cause of quality problems. Fault mode means anything including design flaws or defects, conditions outside of specified specifications, or product modifications that

interfere with the operation of the product. (Herwindo et al., 2017). The use of FMEA is inseparable from the use of Risk Priority Number (RPN) which is the result of multiplying the weight or rating of a failure mode. According to Pamungkas et al. (2020), the critical component with the highest Risk Priority Number (RPN) value will then be built a loss risk mitigation strategy to minimize future losses. There are three main variables in the FMEA process, namely severity, occurrence, and detection. Severity is a rating that refers to the severity of the impact of a potential bug. Impact assessment starts on a scale of 1 to 10, where scale 1 is the mildest impact while scale 10 is the most severe impact. Occurrence is an assessment of how often a product defect occurs. The frequency of occurrence value describes how often a problem occurs due to an underlying cause. Detection is the process of examining the process to specifically identify the root cause of a fault. Detection is a measurement tool to control errors that may occur. The definition of RPN (risk priority number) is a mathematical system that defines a series of effects on severity, so as to be able to make a failure related to effects (occurance), and have the expertise to find failures (detection) before being delivered to consumers. RPN is obtained from the multiplication of the occurance (O), severity (S) and detection (D) ratings. SQC method is used to find the root cause of product defects. The FMEA method is used to identify potential failures in a product or process before they occur, consider the risks associated with those failures, and identify and implement corrective actions to address the most important issues.

3. RESEARCH METHOD

In this research, The flowchart or problem solving steps can be seen in the following Figure 1. Describes the sequence of solving an event that includes investigating existing problems to determine the formulation of problems and research objectives, then determining the dependent variable (Jangelan product quality defects at UD. Rizqi Agung) and the independent variable (type of Janggelan defect). The data processing method in this study uses Statistical Quality Control (SQC) and Effect Mode and Effect Analysis (FMEA). The SQC method data processing technique uses statistical quality control tools, namely control tables, scatter plots, pareto diagrams, histograms, control charts, and effect flow charts followed by Failure Mode and Effects Analysis (FMEA). improvement suggestion with FMEA analysis based on the calculation of the RPN value from the multiplication of Severity (S), Occurance (O), and Detection (D).

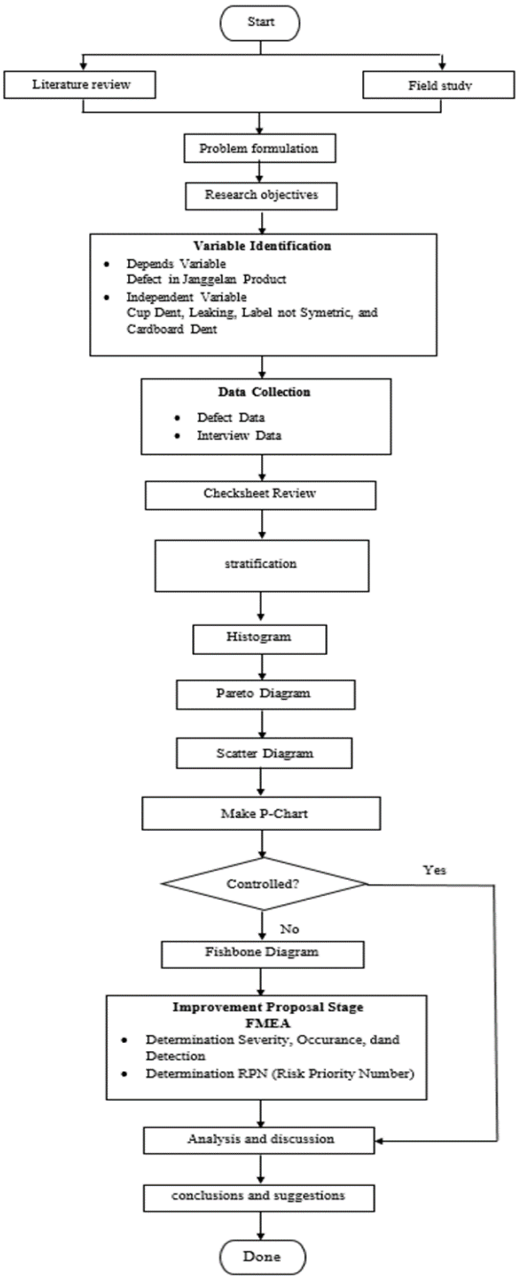

Figure1. Flow chart analysis

4. RESULT AND DISCUSSION

In the calculation using the SQC method and improvement recommendations using the FMEA method with the following results:

4.1 Check sheet

Check sheet is a is a tool designed to facilitate the data collection process. Checklists are used to simply collect, categorize and analyze data to ensure thorough data collection for monitoring and problem-solving purposes. Defect data is the number of products that do not meet the company's quality standards. Defect of Janggelan product can be seen in Table 1.

Table 1. Check sheet defect of Janggelan product

No	Month	Cup Dent (pcs)	Leaking (pcs)	Label not Symetric (pcs)	Cardboard Dent (pcs)
1	January	754	535	280	288
2	February	895	592	278	312
3	March	825	653	266	312
4	April	675	482	181	192
5	May	731	512	255	192
6	June	695	465	175	240
7	July	725	495	212	216
8	August	680	471	177	240
9	September	696	485	192	192
10	October	650	450	187	192
11	November	712	510	231	240
12	December	701	474	195	192

(Source : UD. Rizqi Agung, 2023)

In Table 1, the checksheet data used is UD. Rizqi Agung production data for 1 year, where the checksheet can record the types of defects that are commonly found on in Janggelan products, namely cup dent, leaking, label not symetric and cardboard dent.

4.2 Stratification

Stratification is the step of grouping data into groups that have similar characteristics. Based on the data that has been collected, the defect criteria for janggelan drinks are set with four types of defects. Stratification allows data to be analyzed into meaningful categories or classifications to focus on corrective actions. Stratification can also use data clustering methods to group data into specific categories so that the data clearly explains the problem and makes it easier to draw conclusions.The results of the startification are shown in Table 2.

Table 2. Stratification

No	Month	Production	Cup Dent (pcs)	Leaking (pcs)	Label not Symetric (pcs)	Cardboard Dent (pcs)
1	January	18720	754	535	280	288
2	February	19800	895	592	278	312
3	March	19680	825	653	266	312
4	April	17280	675	482	181	192
5	May	18000	731	512	255	192
6	June	17280	695	465	175	240
7	July	17640	725	495	212	216
8	August	17280	680	471	177	240
9	September	17400	696	485	192	192
10	October	17160	650	450	187	192
11	November	17688	712	510	231	240
12	December	17376	701	474	195	192
Total		**215304**	**8739**	**6124**	**2629**	**2808**

(Source: Production data UD. Rizqi Agung, 2023)

In table 2, stratification of the data used is UD. Rizqi Agung production data for the 1 year,

where in the stratification table can grouping data into groups that have similar characteristics. separate data into subgroups based on certain variables such as, total production in each month, types of defects that are often found, and total defects.

4.3 Histogram

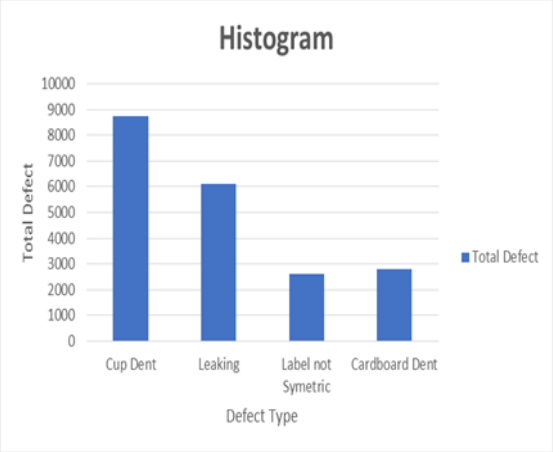

Figure 2. Histogram
(Source : data processing, 2023)

A histogram is a bar chart that depicts a number of data grouped into classes with certain intervals.Based on the histogram, it can be seen that the interval sequence of the types of each defect occurs the most, among others, it is known that the cup dent defect is 8739 pcs, the leaking defect is 6124 pcs, the cardboard defect is dented by 2808 pcs, and the Label defect is not symmetrical by 2629 pcs.

4.4 Pareto Chart

A Pareto diagram is a bar graph that is often used as an interpretation tool to rank each type of defect from largest to smallest. After that, the percentage of defects is calculated and the cumulative percentage of each defect present is calculated. Based on pareto diagram, it can be seen that the most dominant type of defect seen from the cumulative percentage is Cup Dents with a percentage of (43.04%), followed by Leaks with a percentage of (30.17%), then Cardboard Dents with a percentage of (13.83%), and Label not Symetric with a percentage of (12.95%).

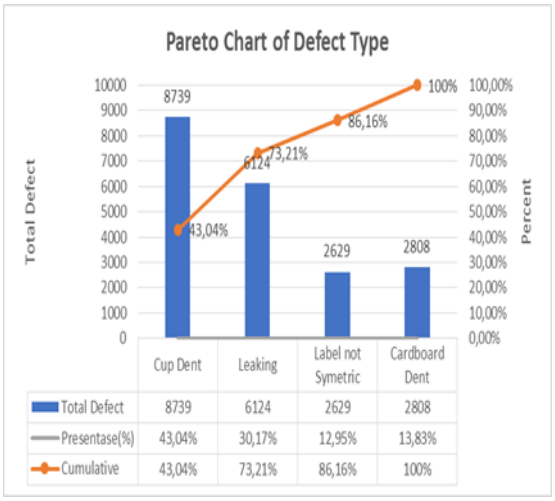

Figure 3. Pareto chart
(Source : data processing, 2023)

4.5 Scatter Diagram

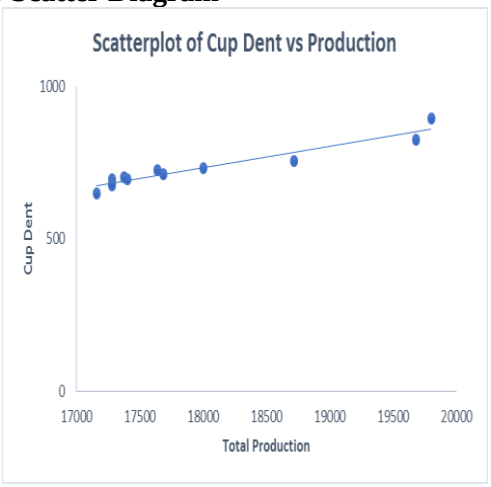

Figure 4. Scatterplot of cup dent vs production
(Source: data processing, 2023)

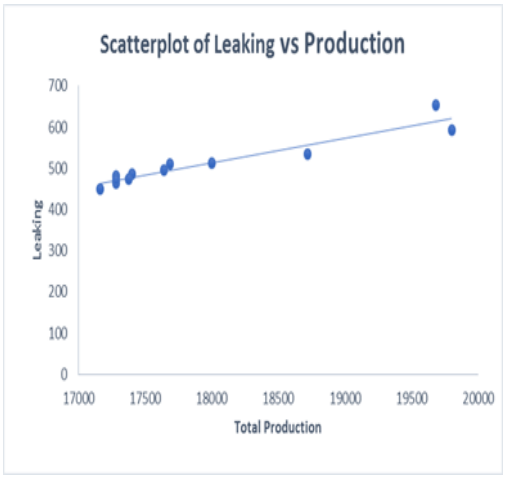

Figure 5. Scatterplot of leaking vs production
(Source: data processing, 2023)

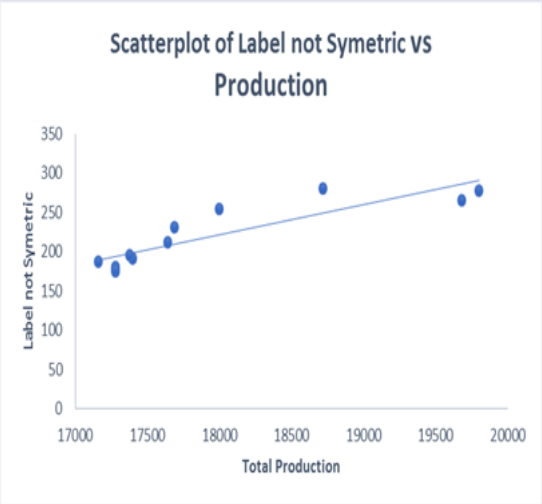

Figure 6. Scatterplot of label not symetric vs production
(Source: data processing, 2023)

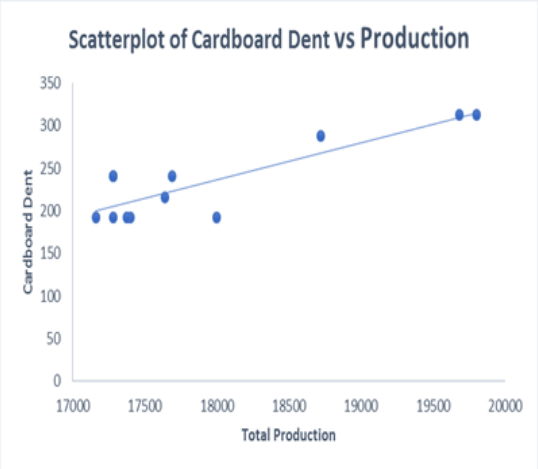

Figure 7. Scatterplot of cardboard dent vs production
(Source: data processing, 2023)

A scatter plot is used to represent the relationship or correlation between two measurements of error factors associated with a feature. Furthermore, the following is a scatter plot to determine the relationship (correlation) between the manufacturing process performed and the number of defects due to cup dents, asymmetrical labels, leaks, and carton dents. Based on the scatter diagram, the four types of defects show the results that of the four types of defects where the increasing variable X is followed by an increase in variable Y, the higher the production, the higher the cup dents. So it can be seen that the scatter diagram above shows that there is a strong relationship between defects and production.

4.6 Control Chart

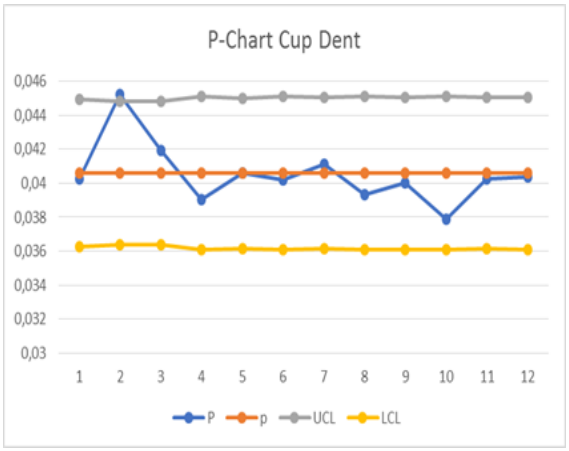

Figure 8. P-Chart cup dent
(Source : data processing, 2023)

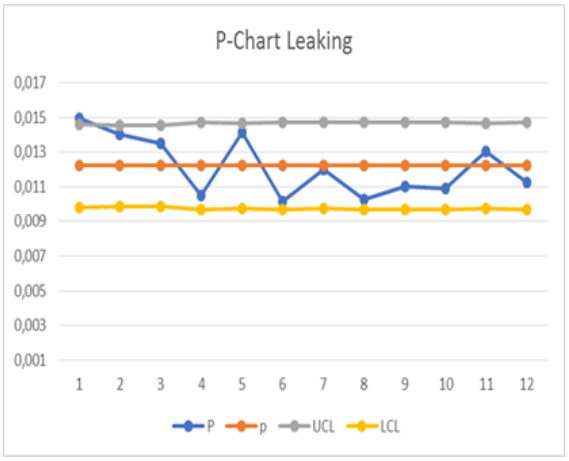

Figure 9. P-Chart leaking
(Source: data processing, 2023)

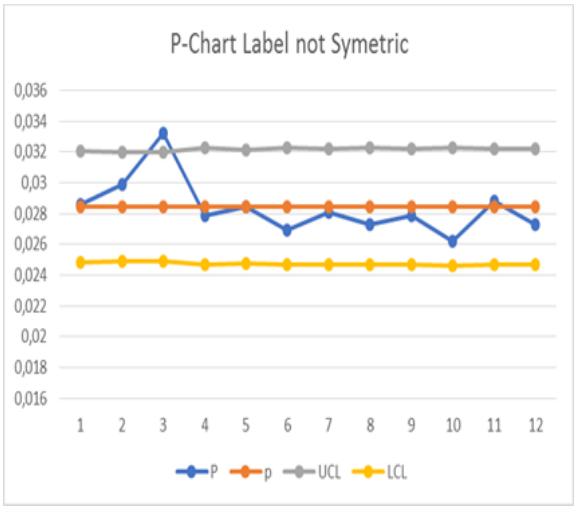

Figure 10. P-Chart label not symetric
(Source: data processing, 2023)

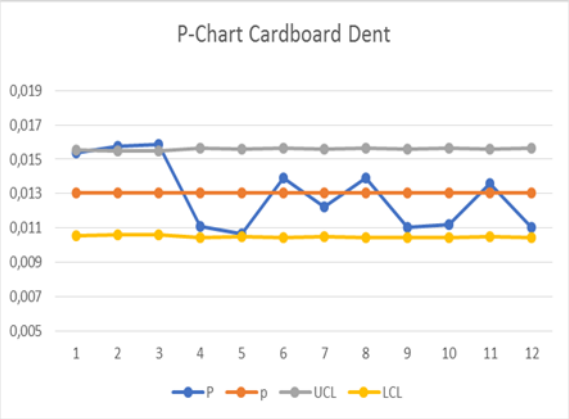

Figure.11. P-Chart cardboard dent
(Source: data processing, 2023)

From the data processing if the value of the proportion of defects of a subgroup is greater than the UCL or smaller than the LCL, it will be counted as out-of-control data. Since there is data that is out of the control limits, it can be concluded that the analysis of defective products in Janggelan products still needs to be continued.

4.7 Cause and Effect

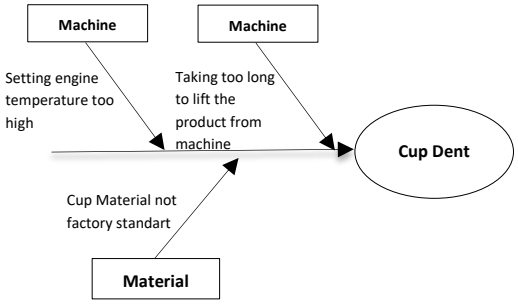

Figure 12. Fishbone diagram cup dent
(Source: data processing result, 2023)

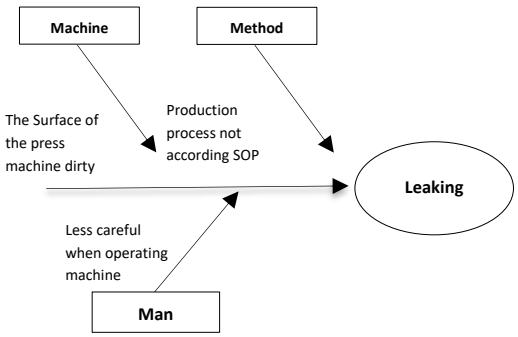

Figure.13. Fishbone diagram leaking
(Source: data processing, 2023)

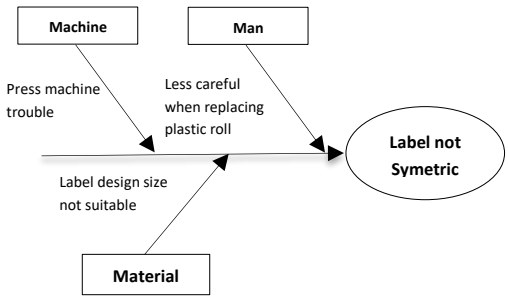

Figure 14. Fishbone label not symetric
(Source : data processing, 2023)

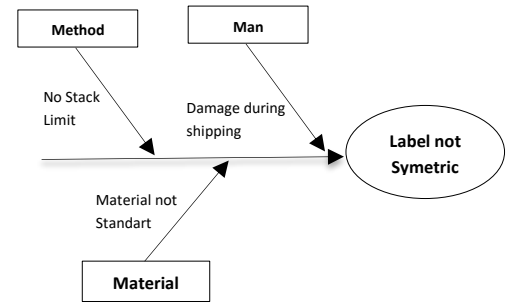

Figure.15. Fishbone diagram cardboard dent
(Source : processed data, 2023)

From Figure 12-15, Fishbone diagrams are useful for analyzing and knowing the most dominant factors that occur. At this stage, the cause of the error is analyzed defect in the Janggelan products studied, namely there are cup dent, leaking, label not symetric, and cardboard dent. Based on fishbone diagram, it can be seen the causes of defects in each factor. Cup dent defects are caused by setting the machine temperature too high, taking too long to lift the product from the machine, and cup material that is not in accordance with factory standards. Leakage defects are caused by dirty press machine surface, less thoroughness when setting the temperature, and a production process that is not in accordance with the SOP. Label not symetric defects defects are caused by the problem is a problematic press machine, lack of care when replacing the plastic roll, and the label design size is not appropriate. Dented cardboard defects defects are caused by there is no stack limit, it is damaged during delivery of

goods, and the cardboard material does not meet SMES standards.

4.8 Failure Mode Effect Analysis (FMEA)

Failure Mode and Effect Analysis (FMEA) is used to identify the source and root cause of quality problems. Fault mode means anything including design flaws or defects, conditions outside of specified specifications, or product modifications that interfere with the operation of the product (Herwindo et al., 2017).

Table 3. Failure Mode Effect Analysis

Potential Failure Mode	Potential Effect Of Failure	Potential Cause	Current Control	S	O	D	RPN
Cup Dent	This is a fatal manufacturing defect because the strength and appearance of the product is not in accordance with the factory standard.	Cup material is not up to standard	Replace the appropriate cup	**8**	**8**	**5**	**320**
Leaking	This is a production defect that is quite fatal due to the press process that is not maximized which results in leakage of the bottled beverage product.	The surface of the press machine is dirty	Cleaning the surface of the press	**6**	**8**	**5**	**240**
Label not Symetric	This is a product defect that can reduce the aesthetics of the bottled beverage product	Less careful when replacing the plastic roll	Implement the SOP for plastic roll replacement	**5**	**7**	**6**	**210**
Cardboard Dent	Product defects are usually caused during the shipping process which can reduce the aesthetic value and can cause product defects in the box.	Damaged during shipping	Giving briefing to delivery driver	**4**	**6**	**6**	**144**

(Source: result focus group discussion with experts, 2023)

After the results of the calculation of Severity (S), Occurrence (O), Detection (D) can then proceed to the calculation of RPN. Then the RPN (Risk Priority Number) can be calculated to determine the top priority for recommended corrective actions.

Table 4. Recommendations for Improvement

Priority	Potential Failure Mode	Potential Cause	RPN	Recommendation
1	Cup Dent	Cup material is not up to standard	360	Always check the condition of the cup before the production process starts regularly, check the product on the sidelines and at the end of each production and change the cup vendor to match the quality requested by UMKM.
2	Cup Dent	Taking too long to lift the product from the machine	280	Monitor employee performance and routinely conduct training so that they are more skilled and Supervise more strictly in the pasteurization section so that there is no carelessness by workers repeatedly.
3	Leaking	The surface of the press machine is dirty	280	Always check the state of the machine before the production process starts regularly and check the production machine in between production.

(Source: result focus group discussion with experts, 2023)

Based on the results, higest RPN value is 320 of the type of cup dent defect with the potential cause that the cup material does not meet SME's standards with proposed improvement recommendations, namely always checking the condition of the cup before the production process starts regularly, checking the product on the sidelines and after each production and changing the cup vendor to match the quality requested by SME'S. The second order higest RPN value of 288 from the type of cup dent defect with the potential cause of taking too

long to lift the product from the machine with proposed recommendations for improvement, namely monitoring employee performance and routinely conducting training so that they are more skilled and supervising more closely in the pasteurization section so that there is no carelessness by workers repeatedly. For the third higest RPN value of 240 from the type of leak defect with the potential cause of the dirty press machine surface with proposed recommendations for improvement, namely always checking the condition of the machine before the production process starts regularly and checking the production machine in between production. With the statistical quality control (SQC) method and improvement with the failure mode and effect analysis (FMEA) method, the company can consider implementing the improvement recommendations that have been given in order to control product quality.

5. CONCLUSION

Based on the results of research on Sari Janggelan Product, the most dominant defect is the Cup Dent defect of 8739 (4.06%), followed by the Leak defect of 6124 (2.84%), the Label is not Symmetrical defect of 2629 (1.22%), and the Cardboard Dent defect of 2808 (1.30%). For the Cup Dent defect, the cause is that the cup material is not according to factory standards and it takes too long to lift the product from the pasteurization machine. Based on the results of the RPN (Risk Priority Number) calculation, the causes of process failures that cause product failure can be determined. The factors are then sorted by RPN value from highest to lowest, and improvement recommendations can be made for each cause. The calculation of the highest RPN values is 320 and 288 of the type of cup dent defect with proposed improvement recommendations, namely always checking the condition of the cup before the production process begins, routinely changing cup vendors to match the quality requested by SME's and monitoring employee performance. Recommendations for further researchers use lean manufacturing methods to deepen the problem because lean manufacturing methods do not only discuss defects, but about 7 wastes that occur in the company.

REFERENCES

Andespa, I. (2020). Analisis Pengendalian Mutu Dengan Menggunakan Statistical Quality Control (SQC) Pada PT. Pratama Abadi Industri (JX) Sukabumi. E-Jurnal Ekonomi dan Bisnis Universitas Udayana. Vol. 19, No. 2. pp 129-160. DOI:10.24843/eeb.2020.v09.i02.p02; Corpus ID: 219128334

Andriyanta, Galang., Aspiranti, T. dan Adwiyah, R. (2020). Analisis Pengendalian Kualitas dengan Menggunakan Metode Statistical Quality Control (SQC) untuk Meminimumkan Produk Gagal Pada Sari Good Bakery. Prosiding Manajemen, Vol. 6, No. 2.

Arif, M. (2016). Bahan Ajar Teknik Industri Edisi 1. Deepublish. Yogyakarta.

Dermawan, M. Arief. (2018). Penerapan Statistical Quality Control (SQC) untuk Megidentifikasi Complain Customer pada PT. Aerofood ACS Cabang Kualanamu. Universitas Sumatera Utara.

Hairiyah, N., Raden R. A., & Eva L. (2019). Analisis Statistical Quality Control (SQC) pada Produksi Roti di Aremania Bakery. Industria : Jurnal Teknologi dan Manajemen Agroindustri. Vol. 8, No. 1. https://doi.org/10.21776/ub.industria.2019.008.01.5

Haryanto, Irwandhani I. S. (2019). Penerapan Metode SQC (Statistical Quality Control) Untuk Mengetahui Kecacatan Produk Shuttlecock Pada Ud. Ardiel Shuttlecock. Jurnal Teknologi Industri Dan Menajemen Vol. 1 No.1.

Hutabarat, J. (2017). Pengantar Teknik Industri. Malang. Media Nusa Creative.

ILO. (2013). Produksi Bersih Produksi Bersih (Issue September). Jakarta: ILO.

Jannah, M., & Siswanti, D. (2017). Analisa Penerapan Lean Manufacturing Untuk Mereduksi Overproduction Waste Menggunakan Value Stream Mapping dan Fishbone Diagram. Jurnal Teknik. Vol. 6, No.1, pp. 1-9. DOI: https://doi.org/10.0001/77

Kuswardani, I., Ni Made S. Y. P., & Heni H. U. (2020). Analisis Pengendalian Kualitas Produk Telur di Persada Farm Dusun Argopeni Desa Sudimoro Kecamatan Srumbung Kabupaten Malang. Jurnal Dinamika Sosial Ekonomi. Vol. 21, No. 2.

pp 105-121.

Manik, A. (2020). Usulan Perbaikan Kualitas Meggunakan Statistical Quality Control (SQC) dan Fuzzy Failure Mode and Effect Analysis (FMEA) untuk Meningkatkan Kualitas Produk Seng di PT. Intan Nasional Iron Industri. Skripsi. Jurusan Teknik Industri. Fakultas Teknik. Universitas Sumatera Utara. Medan.

Marimin, M.Sc., Prof., Dr., Ir (2004). Teknik dan Aplikasi Pengambil Keputusan Kriteria Majemuk. Jakarta : PT.Gramedia Widiasarana Indonesia.

Montgomery, D. C. (2013). Introduction to Statistical Quality Control 7th edition. John Wiley and Sons, Inc.

Nasution, M., N. (2001). Manajemen Mutu Terpadu (Total Quality Management). Jakarta : Ghalia Indonesia.

Novianti, Fenny. (2023). Quality Control of Edamame Products Using Statistical Quality Control (SQC) and Failure Mode Effect Analysis (FMEA) Methods in PT.XYZ. IJIEM. Vol. 4. No. 2. pp 221-230. https://dx.doi.org/10.22441/ijiem.v4i2.20550

Odi, A., Zaman, A. N., Nasution, S. R., & Sundana, S. (2019). Analisis Pengurangan Waste Pada Proses Perawatan Kereta. Jurnal ASIIMETRIK. Vol. 1, No. 1, pp. 34-42.

Purnama, Nursya'bani (2006). Manajemen Kualitas, Perspektif Global. Yogyakarta: Penerbit Ekonisia Fakultas Ekonomi UII Yogyakarta

Rachman, Taufiqur. (2012). Statistic Quality Control (SQC). Jakarta : Universitas Esa Unggul.

Rosyidi, M. R. (2021). Buku Ajar Pengendalian dan Penjaminan Mutu. Malang. Ahlimedia Press.

Saka, A. J., Izekor, J. A., Akeyede, I., Adeleke, M. O., & Adeleke, B. L. (2019). Dual Statistical Quality Control Charts with Table of Quality Determinant in Manufacturing Industries. International Journal of Information Processing and Communication (IJIPC). Vol 7, No. 1. pp 242-252.

Sari, Rianita Puspa. (2018). Analisis Tingkat Kecacatan Produk Lever Assy Parking Brake Menggunakan Metode Statistical Quality Control (SQC). JIEMS Vol. 11, No. 2, 77-83, 2018. DOI: https://dx.doi.org/10.30813/jiems.v11i2.1184

Walujo, D. A., Titiek K., & Yitno U. (2020). Pengendalian Kualitas. Surabaya. Scopindo Media Pustaka.