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Quality Management Analysis Using Seven Tools Case Study of Tinumpuk Tempe Factory

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ABSTRACT

Tempeh is a traditional food typical of Indonesian society. Tempe is in demand by the public not only because of its affordable price, but also because it has a variety of flavors and presentation variations that make it popular from the middle to upper economic class. In recent years, tempeh has also received international attention as a healthy food. However, quality issues are often an obstacle for micro, small and medium enterprises (MSMEs). This study uses quantitative methods to analyze the quality factors of soybean tempeh manufacturing by applying the concept of quality management through seven tools. The results of the analysis show that quality problems in the tempeh production process are black or brown tempeh, consumers do not take orders, soybeans are not washed thoroughly, and the beans are too fluffy. Improvements needed in the production process, selection of quality raw materials, and improvement of employee skills can be the first step to improve the quality of tempeh products. Quality control of tempeh production is expected to have a positive impact, especially in reducing the number of black or brownish tempeh, as well as increasing customer satisfaction.

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1. INTRODUCTION

The modern economic world has given birth to an increasingly advanced global market, competition among business players is increasingly fierce, encouraging the use of appropriate strategies. In this situation, MSMEs have an important role in driving the economy by providing important dynamics in the business world. diverse products, services, and business models, MSMEs not only play a role in local economic growth, but also open up opportunities for economic inclusion and community empowerment. According to Apriani et al., (2023) stated that MSMEs have proven to be a strong pillar in boosting the Indonesian economy in times of economic difficult. In the midst of the economic crisis, MSMEs became saviors by reducing the unemployment rate and creating new jobs.

Saputro (2019) states that Micro, Small, and Medium Enterprises (MSMEs) are the economic stimulus in developing countries. During the global crisis, including in the United States, the impact was felt in Indonesia, especially because of its economic dependence on MSMEs. Miharja et al. (2024) said that community participation in using business products, supported by the government, business actors, and stakeholders, plays a major role in economic development. Both SMEs and large-scale businesses are important pillars in supporting economic growth.

One of the MSMEs that is very important for the community is the Tempe factory. According to Agustina (2022) tempeh has been a typical Indonesian food since ancient times, originating from

the Yogyakarta and Surakarta areas. Javanese people who migrated during colonization spread it throughout the archipelago, making tempeh common throughout Indonesia, including eastern Indonesia. There is a community institution that plays a role in the procurement of tempeh raw materials, namely PRIMKOPTI. According to Lubis et al. (2019), PRIMKOPTI functions as a solution to the challenge of soybean supply for tempeh MSMEs with limited capital. As a platform, PRIMKOPTI facilitates access to soybeans while providing support and coaching to tempeh and tofu craftsmen.

The problem that is often faced by MSME actors is that they do not have standards in the implementation of production. According to Vicky Nanda Agusti et al., (2022) In the context of business formation, it is important to follow the correct procedures, including involving facilitators from agency cooperation. This cooperation can be key in ensuring proper business formation mechanisms, by providing the necessary guidance and support. In MSMEs, the tinumpuk tempeh factory does not have good quality standards so that there are problems that occur in the production process as well as in the tinumpuk tempeh factory located in Pondoh Village, Juntinyuat Subdistrict, Indramayu Regency as seen in the check sheet table below which can illustrate this.

Table 1. Check Sheet of Factors affecting Tempeh Quality at Tinumpuk Tempeh Factory

No.	Problems that Occurred	Frequency of Occurrence, (2 weeks) February														Total
		18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Beans are too fluffy	9	7	2	13	0	3	0	1	1	0	5	0	0	1	42
2	Consumers do not pick up orders	7	11	5	4	11	9	6	5	6	3	2	10	7	5	91
3	Black/brown tempeh	20	15	7	23	0	17	7	3	14	13	6	14	6	5	150
4	Soybeans are not washed thoroughly	9	4	4	5	0	9	4	0	8	6	1	6	2	1	59
Daily Production		106	104	90	105	80	109	100	130	109	111	124	119	114	102	1503

Source: UMKM Tinumpuk Tempeh Factory (2024)

Data collection using check sheets that have been carried out found that several things are important points in controlling the quality of the production flow. For example, there were 42 cauldrons of beans that were too fluffy, 91 customers did not pick up their orders, 150 packs of black/brown tempeh, 59 cauldrons of soybeans that were not cleaned properly due to the production process from start to finish that determines whether the product is quality or failure. Then conduct an analysis using seven other tools to identify the main causes of the problem and create solutions to the problem.

Veronika Zendrato et al., (2022) have examined quality control in Mr. Warianto's tempe factory for 10 days, with daily production reaching 80 packs of tempe. The results showed that there were 78 defects in production, which consisted of four types of defects, namely blackish color (15 pieces), animal-eaten defects (27 pieces), damaged packaging (14 pieces), and damaged packaging (14 pieces), uneven shape (22 pieces). With a defect percentage of 9.75% of the total 800 products, this study underscores the need for more attention in quality control to reduce the number of defects and improve production efficiency. This study provides important insights in the effort to improve the quality of tempeh products in the factory.

This is also reinforced by data from previous research conducted by Ariyanto & Rofiq, (2021), the processed data shows that Siti Zubaedah's tempeh chips are mushy, brown, and dirty. Tempeh production in 2021 experienced a 19.81% defect. This defect is caused by methods, environment, people, machines, and raw materials.

2. METHOD

Sugiyono (2017) defined the research method as a scientific approach in data collection with specific purposes and applications and also still according to Sugiyono (2017) The use of quantitative methods was chosen because the data obtained through collection, processing, and monitoring through structured statistical procedures, and this research is numerical and based on numbers. Referring to research conducted by Utami Dewi et al., (2021) suggests the application of quality

management control using the QC 7 tools method is a research analysis with quantitative methods. This is in line with the current study using the seven tools quality control management tool and quantitative methods used to measure the number of production failures of tempeh products to analyze through 7 tools.

Denscombe (2014) said that in research design, it involves designing the research with clear objectives and planning how to achieve them in advance. Quantitative research is often associated with a structured research design where the analysis process is clearly separated from the data collection process.

A sample is a subset or part taken from the population to be tested or observed further. The sample is selected with the aim of representing the population as a whole, so that the results of the sample analysis can be considered representative of the population more generally. (Nuryadi, 2017)

The population in this study includes all information related to product quality and operations management processes that occur in the tempeh factory. This includes data on various factors that affect tempeh production, such as the manufacturing process, quality control, and operational aspects of the factory.

According to Leavy & Patricia (2017) Samples refer to a number of individual cases that are selected to be subjects in a study, and from which data is collected. The sampling process is very important in research because the selected sample must accurately represent the larger population or the phenomenon being studied.

The sample taken in this study was a tinumpuk tempeh factory with tempeh production that was damaged within a period of 2 weeks, covering every stage of the process from raw material preparation to production completion. This research focuses on controlling the quality of tempeh against various types of damage that occur during this time span.

Leavy & Patricia (2017) said that sampling techniques are based on the principle that the best information can be obtained by focusing on a small number of purposefully selected samples, based on known attributes, rather than through random selection.

This research also uses snowball sampling techniques. According to Sugiyono (2017), snowball sampling technique is a technique of taking data sources which at first the number is small then becomes larger, this is because initially the focus of the research was on operations management. However, as the research progressed, the scope of the topic became broader and more comprehensive, involving other aspects related to quality management, such as the influence of external and internal factors, implementation strategies, and the impact on product success.

3. RESULT AND DISCUSSION

The following are some of the quality control activities carried out by the tinumpuk tempeh factory MSMEs.

Check Sheet

A check sheet is a sheet or form used to record data. It is one of the simplest methods to collect data and determine trends. Records can be used to determine the occurrence of events. (S. Uthanu Mallayan & M. Pugazh, n.d.)

In this study, the Check Sheet is useful for identifying the types of defects, recording the number, and analyzing quality problems in tempeh production.

Table 2. Check Sheet of Quality Issues at Tinumpuk Tempeh Factory

No.	Problems that Occurred	Total
1	Black/brown tempeh	150
2	Consumers do not pick up orders	91
3	Soybeans are not washed thoroughly	59
4	Beans are too fluffy	42
Total		342

Source: UMKM Tinumpuk Tempeh Factory (2024)

After collecting data using a check sheet, it was found that several things were important points in controlling the quality of the production flow. With this approach, it is expected to reveal the root of the problem and take steps to find the right solution to improve product quality.

Histogram

Mitra (2016) said in his book that distribution plots can be used for quantitative data. In this case, the values of the quality characteristics are obtained on a measurable scale. Rarely do we get an overview of the process characteristics by simply looking at the individual data values collected from the process. Such data is often overwhelming. Frequency distributions and histograms summarize such information and present it in a format that allows us to draw conclusions regarding the condition of the process. In this study, the data is processed from the total check sheets that we have collected at tinumpuk tempeh factory. The following table presents the type and magnitude of the frequency distribution of defects in tempeh:

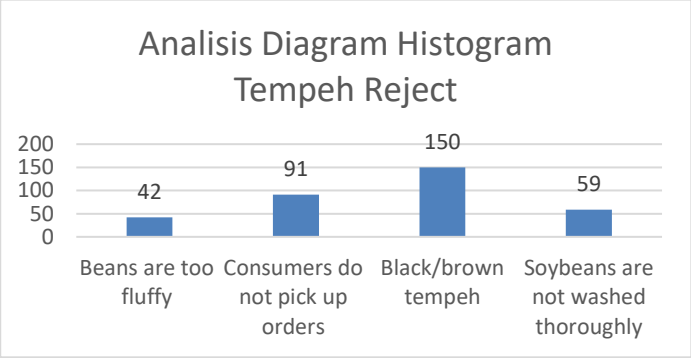

Figure 1: Histogram Diagram Results of Tempeh Failure Causes

Source: Data Processed by The Author (2024)

The results of the percentage of defective products can be made a histogram diagram can be seen in the table above shows that: Peanuts are too fluffy by 42 cauldrons, Consumers do not take orders 91 times, Tempeh is black / brown by 150 packs, Soybeans are not washed clean 59 cauldrons. the data was taken during a 2-week period in early February.

Diagram Pareto

Pareto diagrams help prioritize problems by arranging them in decreasing order of importance. In an environment with limited resources, this diagram helps companies decide the order in which problems should be addressed. (Mitra, 2016)

Table 3. Causes of Tempeh Failure Problems

No.	Problems that Occurred	Total	Percentage	Cumulative Percentage
1	Black/brown tempeh	150	43,86%	43,86%
2	Consumers do not pick up orders	91	26,61%	70,47%
3	Soybeans are not washed thoroughly	59	17,25%	87,72%
4	Beans are too fluffy	42	12,28%	100,00%
Jumlah		342	100,00%	

Source: Data Processed by The Author (2024)

The data in the table has been obtained by adding the percentage of occurrence and cumulative percentage for each problem recorded. Black/brown tempeh recorded the highest percentage of occurrence at 43.86%, followed by customers not picking up their orders at 26.61%. Furthermore, the problem of unwashed soybeans had an incidence of 17.25%, and over-expanded beans at 12.28%. The cumulative percentage shows the accumulated percentage from the first to the last problem, with a grand total of 100%.

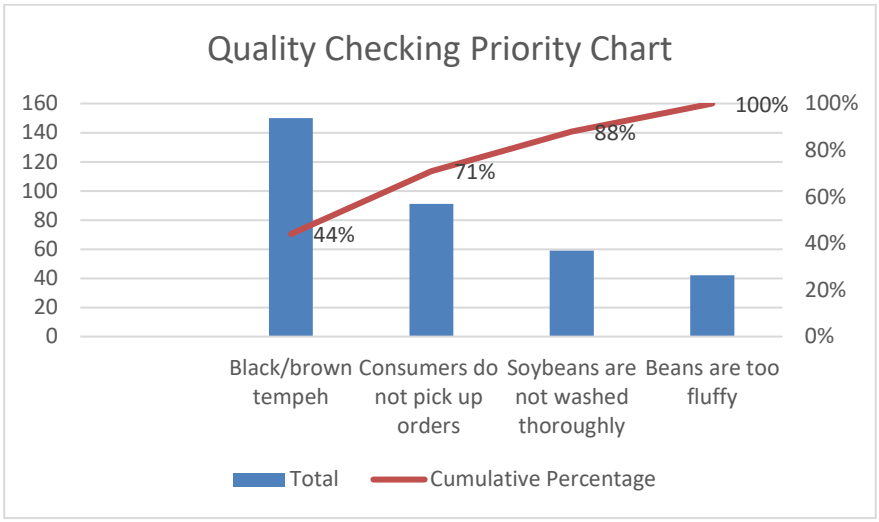

Figure 2: Pareto Chart of Quality Check Priorities
Source: Data Processed by The Author (2024)

Pareto diagrams in this study can identify and prioritize the main problems that need to be addressed to improve quality in the tempeh production process at the tinumpuk tempeh factory.

Diagram alur (Flow Chart)

A flow chart is a simple yet powerful tool in visualizing a process or system using annotated boxes and interconnected lines. Creating a flow chart for a process is a very important first step in an effort to improve the process for the benefit of the company. (Heizer et al., 2020)

Flow chart of the process of making tempeh in the tempeh tumpuk factory can be arranged to describe the sequence of steps that must be passed. The following is the flow of the tempeh making process at the tinumpuk tempeh factory business.

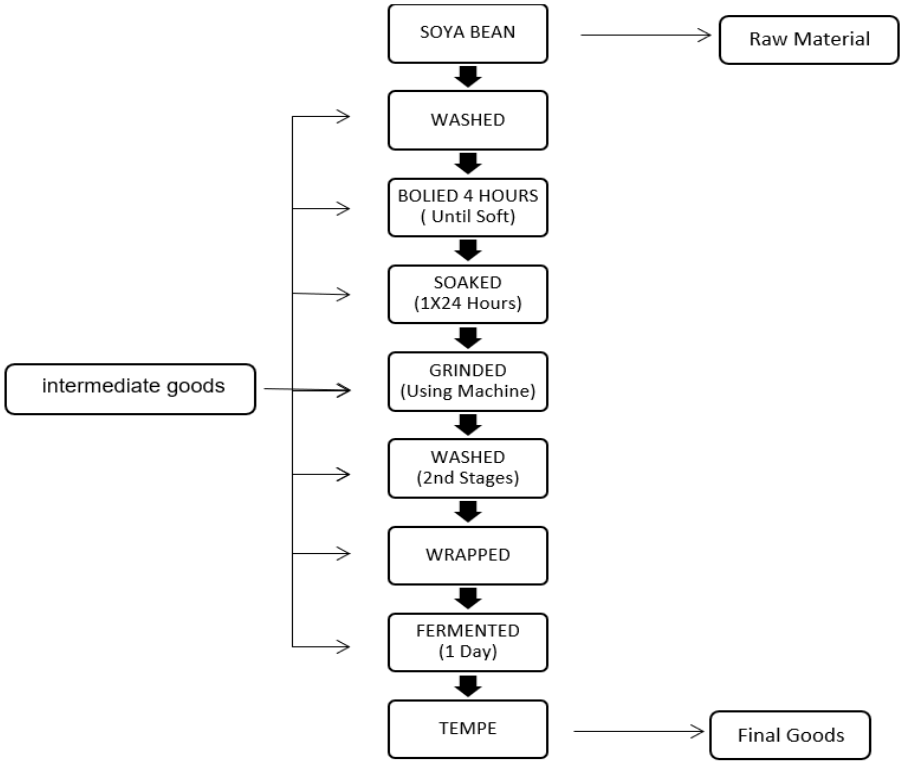

Figure 3: Flowchart of Tinumpuk Tempeh Process
Source: Data Processed by The Author (2024)

The process of making tempeh usually begins with steps such as the selection and soaking of soybean seeds, the process of grinding or pulverizing the seeds, mixing with tempeh culture or yeast, the fermentation process in certain temperatures and conditions, to the stage of maturation and cutting into pieces of tempeh that are ready for consumption. Here are the steps from start to finish for a more detailed explanation:

a). soybeans are washed to remove impurities. b). soybeans are boiled for 4 hours until soft. c). Soybeans are soaked for 24 hours. d). Soybeans are ground using a machine. e). Soybeans are washed again in the second stage to remove any impurities that may remain. f). The soybeans are then wrapped. g). Water is added to the fermentation process, and the tempeh is left for 1 day for fermentation.

Scatter Diagram

A scatter diagram shows the relationship between two measurements. An example is the relationship between the length of a service call and the number of trips made by the repair person back to the truck to pick up parts. Another example is a plot of productivity and absenteeism. (Heizer et al., 2020)

Table 4. Stocking diagram

Date	Quality Issues	Production
18	45	106
19	37	104
20	18	90
21	45	105
22	11	80
23	38	109
24	17	100
25	9	130
26	29	109
27	22	111
28	14	124
29	30	119
30	15	114
31	12	102

Source: Data Processed by The Author (2024)

Table 4 presents data on the quality problems that occurred on a certain number of dates. In this table, the first column indicates the date the observation was made, followed by the number of quality issues recorded in the second column. The last column displays the average number of quality issues per day for each observed date. From the data, there is a significant variation in the number of quality issues from one day to the next, with a considerable range of 9 to 45 issues per day. In addition, the average number of quality issues per day also varies, with a range between 2.25 to 11.25 issues per day. The use of scatter diagrams can help further visualize the relationship between date and number of quality issues, allowing for the identification of patterns or trends that may be present in the data.

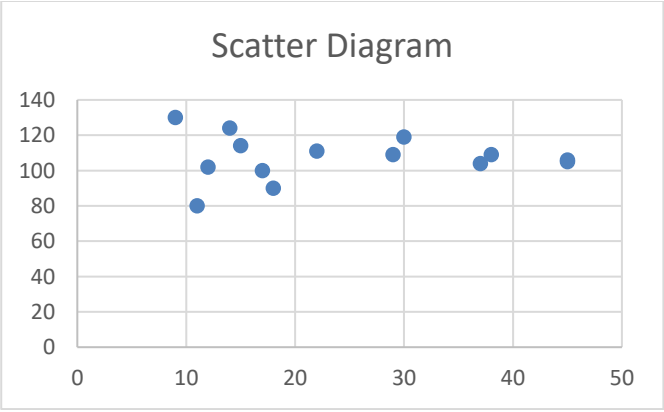

Figure 4: Scatter diagram

Source: Data Processed by The Author (2024)

Scatter Diagram of four variables namely "Tempeh is black/brown", "Consumer does not take the order", "Soybeans are not washed clean", and "Beans are too fluffy", affecting defects in tempeh products. From the output chart display, we can identify that the pattern formed on the scatter plot graph tends to deviate to the right, indicating that the data tends to be normally distributed. This indicates that there is a relationship between the variables and defects in tempeh products, where some of the factors may have a greater contribution to the occurrence of defects in tempeh than others. Therefore, a deeper understanding of the relationship between these variables can help producers identify areas for improvement or further attention in the tempeh production process to reduce the risk of product defects.

Control Chart

Control charts are powerful tools in quality control that monitor process behavior statistically, helping to identify process stability and control with centerline, UCL, and LCL. (Luthra et al., 2021). Meanwhile, according to Heizer et al., (2020), control map analysis is used to monitor and explain the status of quality control in the tempeh production process at the factory. The steps to create this control map include calculating the average defective product, as well as determining statistical control limits such as UCL (Upper Control Limit), CL (Center Line), and LCL (Lower Control Limit). This process helps in identifying whether the production process is under control or has deviations. The following are the steps of applying and making control map tools on tempeh products at tinumpuk factory.

A. Calculating the average defective product

$$\overline{C} = \frac{\text{Number of Damaged Products}}{\text{Total Production Yield}} \text{ x } 100\%$$

B. Calculating Defects (C) and Control Limits

$$\underline{C} = \frac{\sum C}{K}$$

$$UCL = \overline{C} + 3\sqrt{\overline{C}}$$

$$LCL = \underline{C} - 3\sqrt{\overline{C}}$$

Description:

C = Defect
K = Total number of observations
$\underline{C}$ = Control Limit = $c \pm 3\sqrt{c}$
$\sqrt{\overline{C}}$= Standard deviation

C. Control limit calculation

Calculating CL (Center Line)

$$CL = \underline{C}$$
$$CL = 24{,}43$$

Calculating UCL (Upper Center Line)

$$UCL = \overline{C} + 3\sqrt{\overline{C}}$$
$$UCL = 62{,}68$$

Calculating LCL (Lower Center Line)

$$LCL = \underline{C} - 3\sqrt{\overline{C}}$$
$$LCL = -13{,}82$$

Table 5. Tempeh Product Failure Proportion

Date	Productions	Quality Issues	Percentage	Proportion	CL	UCL	LCL
18	106	45	42%	0,42	24,43	62,68	-13,82
19	104	37	36%	0,36	24,43	62,68	-13,82
20	90	18	20%	0,20	24,43	62,68	-13,82
21	105	45	43%	0,43	24,43	62,68	-13,82
22	80	11	14%	0,14	24,43	62,68	-13,82

23	109	38	35%	0,35	24,43	62,68	-13,82
24	100	17	17%	0,17	24,43	62,68	-13,82
25	130	9	7%	0,07	24,43	62,68	-13,82
26	109	29	27%	0,27	24,43	62,68	-13,82
27	111	22	20%	0,20	24,43	62,68	-13,82
28	124	14	11%	0,11	24,43	62,68	-13,82
29	119	30	25%	0,25	24,43	62,68	-13,82
30	114	15	13%	0,13	24,43	62,68	-13,82
31	102	12	12%	0,12	24,43	62,68	-13,82

Source: Data processed by the author (2024)

Table 5 presents data on the proportion of tempeh product failures over a period of time. Each entry in the table includes information about the date of production, the total amount of production, the number of quality problems that occurred, as well as the percentage of product failure in the form of percentage and proportion. The percentage of failure is calculated by dividing the number of quality problems by the total production on that day. In addition, the table also lists the values for the Central Line (CL), Upper Control Limit (UCL), and Lower Control Limit (LCL). The CL is the average value of the proportion of failures for the entire time period, while the UCL and LCL indicate the upper and lower limits of acceptable variability. This data is important for tempeh factory management to monitor the quality of their products as well as to identify significant changes in failure rates.

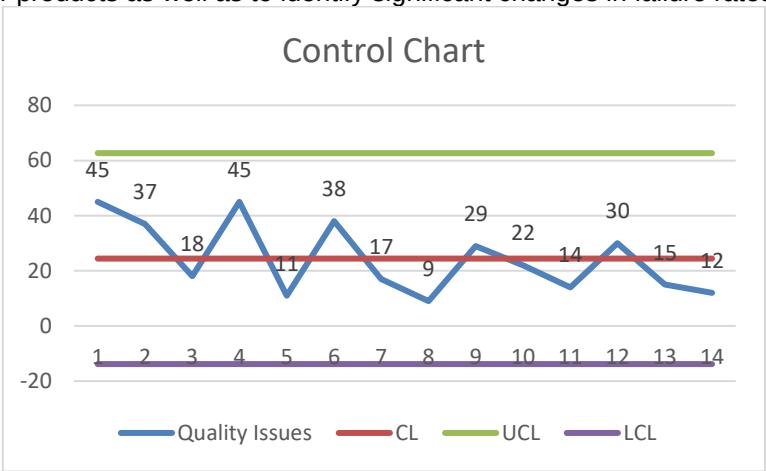

Figure 5: Control Chart

Source: Data processed by the author (2024)

The interpretation of the values found in the p chart control map of the tempeh factory data is as follows:

1. The CL (Center Line) value is 24.43: This indicates the average proportion of tempeh product defects in the production process. If the value of the proportion of defects is around the CL, it indicates that the production process is running according to its historical average.
2. UCL (Upper Control Limit) value of 62.68: This indicates the upper limit at which a defect proportion value is considered unusual or out of control. If the defect proportion value exceeds the UCL, it could indicate a problem or deviation in the production process that needs to be addressed.
3. LCL (Lower Control Limit) value of -13.82: This indicates the lower limit at which a value of the proportion of defects is considered unusual or out of control. In this context, a negative LCL value may indicate an error in tempeh manufacturing.

Thus, the overall interpretation is that the tempeh production process is largely under control with an average value of proportion of defects of 24.43. However, there is a tendency that there is considerable variation in the proportion of defects, as the UCL and LCL are quite far from the CL. This indicates the need for extra attention to the quality of tempeh products to ensure that the proportion of defects remains within acceptable control.

Fishbone Diagram

A cause-and-effect diagram, or Ishikawa diagram, is a tool for identifying quality problems and inspection points by highlighting potential faults such as materials, machines, labor, and methods. Through decomposing individual causes in these categories, quality problems and inspection points can be identified more systematically. (Heizer et al., 2020)

The following is a fishbone diagram of the tinumpuk tempeh factory business:

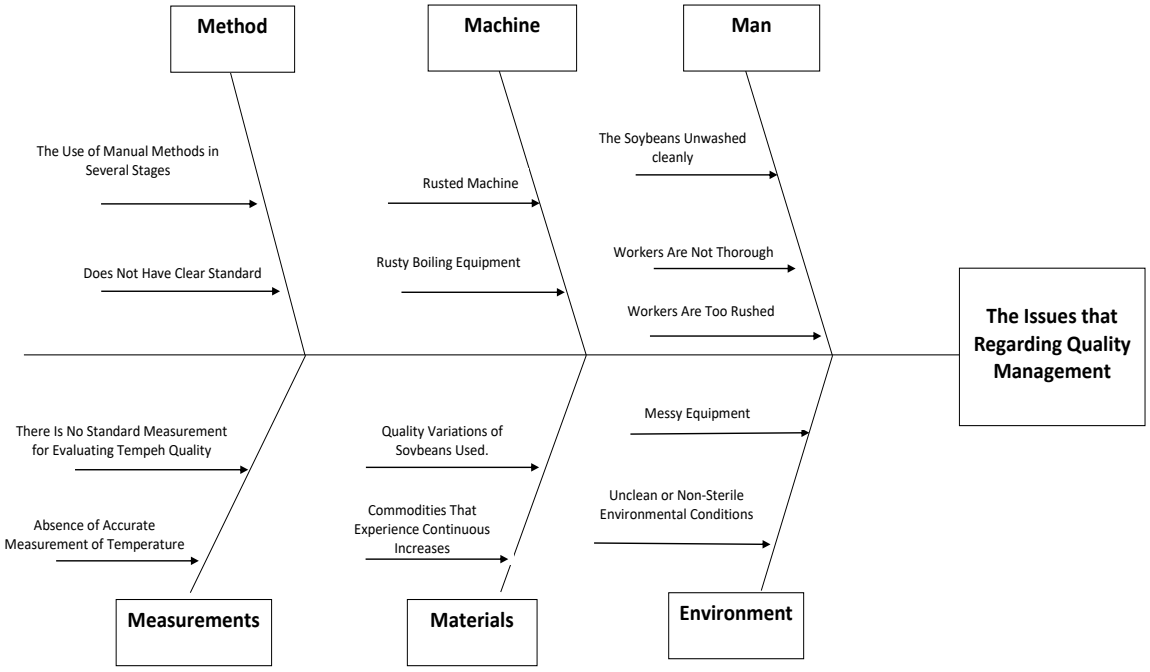

Figure 6: Fish Bone Diagram
Source: Data Processed by The Author (2024)

4. CONCLUTION

The production flow at the tinumpuk tempeh factory has 7 stages, including first, the soybeans are washed to remove dirt. Second, the soybeans are boiled for 4 hours until soft. Third, soybeans are soaked for 24 hours. Fourth, soybeans are ground using a machine. Fifth, the soybeans are washed again in the second stage to remove any dirt that may remain. Sixth, the soybeans are then wrapped. Seventh water is added to the fermentation process, and the tempeh is left for 1 day for fermentation. Of the seven stages, the most dominant problem is in the washing stage due to the fact that workers are less careful in the process, the environment and tools used in the tempeh making process also affect the cleanliness of soybeans with a note of improvement in the direction of workers. Samples of tempeh observed during the research process obtained 4 types of damage / defects in the product, namely, the first problem that occurs is black / brown tempeh, second consumers do not take orders, third soybeans are not washed clean, and the last beans are too fluffy. According to 1503 total samples there were 342 tempeh that experienced defects, black/brown tempeh defects were the most dominant type of defect with a percentage of 43.86%. that way this type of defect becomes a top priority in quality control. After calculating the control chart, it was found that the results of the proportion value were all still within the control limits, none of which passed the upper control line. Factors of tempeh product defects come from the environment, people, machines, methods, materials where the main cause is in the process of washing soybeans and environmental factors where the place is less clean, this can be seen in the most dominant type of defect. Beans that are too fluffy are caused by poor raw materials.

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