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Integrating Seven Tools and Kaizen Approach in Evaluating Defects on Tofu Production Process

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Abstract

UKM Tofu ADA is a tofu producer that makes an effort to develop the quality standardization of the tofu production process. Managing tofu quality through maintaining the production process is challenging, resulting in no good tofu. Defective products cause economic loss and the inability to fulfill customer orders. This study aims to evaluate defects in the tofu production process using the Seven Tools and Kaizen approach. The results of this study configure three types of product defects. Namely, mushy, cracked, and crushed. The highest percentage of defects is mushy tofu, with 43.8%. The proposed improvement using kaizen analysis is the Kaizen Five-M Checklist.

Keywords: Seven tools, Kaizen, Tofu, Quality, Defects

Abstrak

UKM Tahu ADA merupakan produsen tahu yang berupaya mengembangkan standarisasi mutu proses produksi tahu. Produk tahu berkualitas dihasilkan dari pengelolaan sepanjang proses produksi. Home industry ADA mengalami kendala dalam mengelola konsistensi sepanjang aliran produksi tahu sehingga produk akhir mengalami kecacatan. Produk yang cacat menyebabkan kerugian ekonomi dan ketidakmampuan untuk memenuhi pesanan pelanggan. Penelitian ini bertujuan untuk mengevaluasi kecacatan yang terjadi pada aliran proses produksi tahu dengan menggunakan metode Seven Tools dan Kaizen. Hasil penelitian ini mengidentifikasi tiga jenis cacat atribut tahu, yaitu tahu lembek, permukaan tahu retak, dan tahu hancur. Persentase cacat tertinggi adalah tahu lembek, yaitu sebesar 43,8%. Usulan perbaikan menggunakan analisis Kaizen Five-M Checklist.

***Kata-kata kunci**: Seven tools, Kaizen, Tahu, Kualitas, Kecacatan*

1. Introduction

In the 5.0 Industrial Era, competition is getting more challenging. Enterprises have to face competition from import producers, and the goods are not much different from other domestic producers [1]. The development of the industrial world is enormous, which affects numerous subjects, both manufacturing and service industries [2]. Therefore, product quality is the primary factor determining a company's accomplishment or catastrophe in marketing its products [3]. Maintaining product quality is the company's goal to meet customer needs and satisfaction.

Micro, small, and medium firms are the majority of business scales in Indonesia and reside through regions [4]. UMK Tofu ADA is a medium-sized business founded in 2001, engaged in the tofu manufacturing process. Tofu is a soybean-based food that is one of the prominent local foods in Indonesia. This company produces 13,000 pieces of tofu per day. In addition, the tofu production process is known as the traditional make-based of the production process. The production stages start from soaking soybean, grinding, boiling, filtering, cutting, and packaging. Tofu is the end goods that essential be met the customers' demand in terms of quality. This quality standard includes softness and size. However, defects have been found during the production process. **Figure 1** is visualizes no good tofu.

Figure 1. a) Mushy Tofu, b) Cracked Tofu, c) Crushed Tofu.

Three figures are show that three kinds of tofu defects gain a negative impact in terms of economic and the producer's reputation. The factors that influence the occurrence of product defects are machines, people, materials, methods, and the environment [5] . The home-industry owner has been figuring out how to sustain god quality products through the production line.

Statistical Quality Control is known as one of the comprehension approaches to managing quality. In addition, the seven tools approach is known as a statistical tool used to control quality [6]. Seven stages in maintaining quality are depicted as follows. Check Sheet is a data collection tool to simplify data recording [5]. A flowchart is a step-by-step process for completing the analysis, discussion, and communication tasks [7]. A histogram is a bar chart-

like tool used to display frequency distributions. The frequency distribution shows how often each different value in the dataset occurs [8]. Pareto charts are bar charts and line chart tools used to compare different data types. This diagram serves to display the problem so that it knows how to solve the problem [3]. Control Chart is a tool to evaluate changes in data and the causes of deviations [9]. Scatter Diagrams are used to determine the causes of two data [9]. The Cause and Effect Diagram is a tool that functions to determine the factors [5].

Kaizen analysis is a tool for the causes of damage from aspects of humans, machines, methods, materials, tools, and the environment, resulting in an improvement to eliminate waste and workload and improve quality [10]. This method is excellent for improving company performance, namely 5S (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) [11]. Furthermore, Seiri is the activity of selecting goods according to their function. Seiton is putting things in their proper place so they are easy to find. Seiso tidies the work environment, and Seiketsu is to keep it tidy. Furthermore, Shitsuke obeys the rules and has a disciplined attitude [11].

An empirical study using the integration of Seven Tools and Kaizen in manufacturing and service businesses has effectively instigated managing quality [10]. However, this study has differences in comparison to previous studies. The priority of this research is that the application of seven tools can detect products along with the production flow. In contrast, this study uses the Kaizen Five-M Checklist to design an improvements scenario based on the results obtained in the seven tools analysis [12]. The next difference is that the empirical research was conducted in a big firm [12]. Meanwhile, this study is a medium-sized firm and food producer.

This study aims to identify, analyze the occurrence of defects, and determine options for improving the quality of tofu production to minimize the level of defects. The method used in this research is seven tools and Kaizen improvements. Furthermore, seven tools and the Kaizen approach have proven practical techniques to maintain and improve the quality of goods and services and satisfy customers [6]. Quality control purposes of producing products according to the expected and planned standards and improve the quality of products that do not meet predetermined standards [13].

2. Method

This research is descriptive quantitative, and the analysis was carried out using descriptive qualitative methods. Descriptive analysis was based on a calculated result of defects using Seven Tools and Kaizen.

The data collection stage was carried out directly through field observations. The data collected were then analyzed using the Seven Tools: 1. Check Sheet was used in the tofu production process where data were recorded using a check sheet; 2. Flow Chart refers to stages of the process from raw materials to end-products; 3. Histogram was used to determine the number of production and product defects; 4. Pareto was used in calculating the types of defects that are the largest; 5. Control Chart was used to determine the number of defects; 6. Scatter Diagram was to find out the x and y variables in tofu production, and 7. Fishbone Diagram was used for analyzing the causal determination of the relationship between the problem and the possible factors that cause disability. The identified factors include raw materials, machines, people, methods, and the environment [6]. Furthermore, based on the analysis of the Ishikawa diagram, the next stage was analyzed to gather a better scenario with the Kaizen Five-M Checklist. Kaizen prioritizes processes and uses the current value to support quality improvement [13].

3. Results and Discussion

The seven tools analysis results have been calculated: Check sheet, Flowchart, Histogram, Control Chart, Scatter Diagram, Pareto Diagram, and Fishbone Diagram. Check Sheet. The tofu product defect is presented in Figure 2.

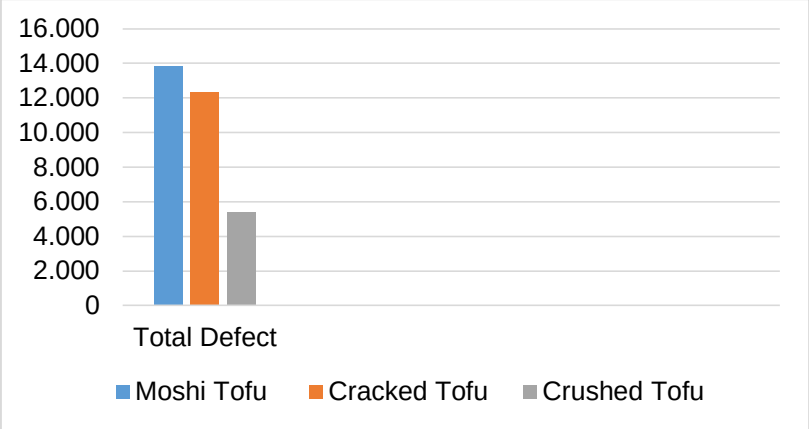

Figure 2. Number and Type of Defect

Figure 2 inform total production for one month is 409.522 pcs of tofu. The following defects in tofu products include 13,847 pcs of mushy tofu, 12,330 pcs of cracked tofu, and 5,437 pcs of crushed tofu. The total number of defects are 31,614 pcs tofu.

Flow Chart was used to identify the production process from raw materials to finished products. The flow chart of the tofu production process can be seen in **Figure 3**.

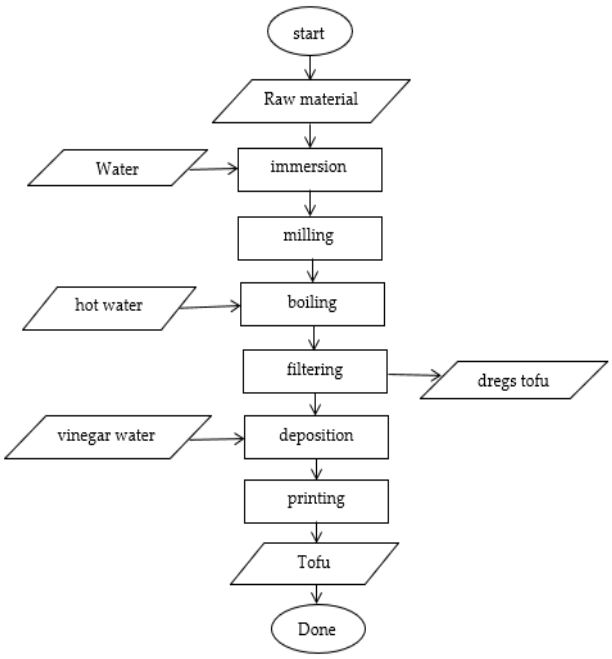

Figure 3. Flow Chart of the Production Process

Figure 3 shows the production process of tofu. Making tofu starts with the soybean soaking process, then the grinding process. Once the grinding process is done, next is the boiling process, followed by the filtering process to separate the tofu grounds from the tofu extract and then attaching vinegar. Once the coagulating process is done, the tofu pressing process is done by pressing tools to finish the goods.

This histogram data was used to determine defects in tofu products. This histogram data is data for one month. The histogram is illustrated in **Figure 4**.

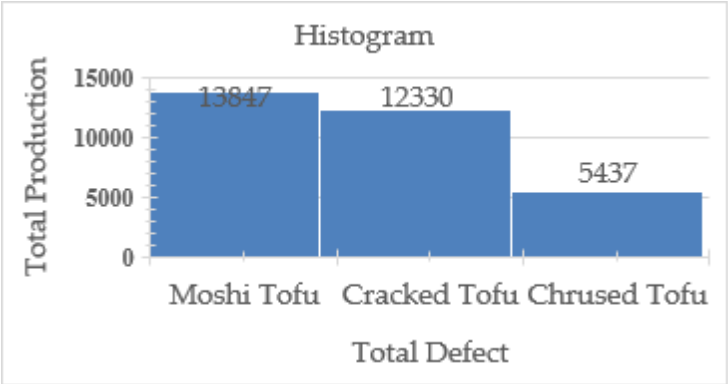

Figure 4. Histogram of the Number of Types of Defects

It can be seen in **Figure 4** that the defects that have the highest number are 13,847 soft tofu defects, while for the minor results, crushed tofu defects are 5,437.

The Pareto chart was used to determine the percentage of defects occurrence. **Figure 5** illustrates the Pareto Diagram.

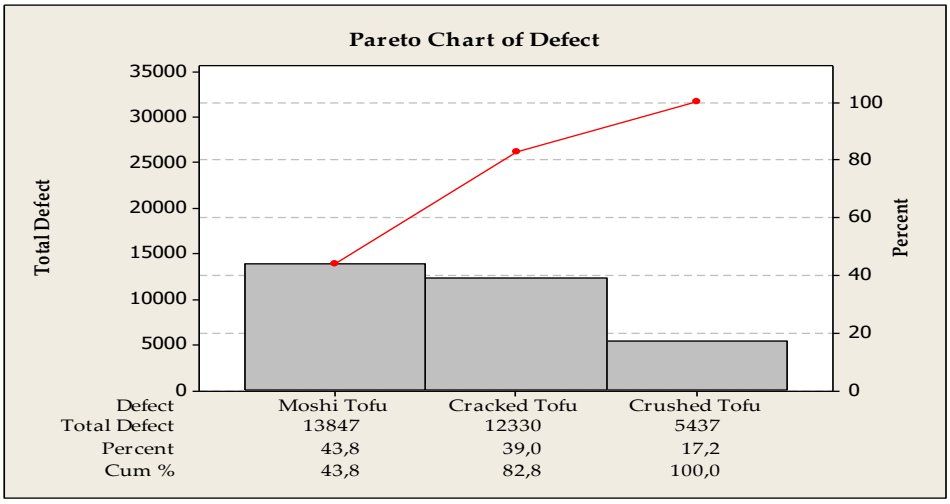

Figure 5. Pareto Diagram

Figure 5 shows the type of product defect that often occurs in tofu production is mushy tofu, with 43.3%. In comparison, cracked tofu is at 39.0%, while the minor product defect is crushed tofu with a percentage of 17.2%.

Control charts are used to see if the process is quality control. Figure 6 depicts Control Chart. The steps in the control chart are calculating the percentage of damage and the Central line (CL), calculating the Upper Control Limit (UCL), and the Lower Control Limit (LCL). The p control chart used is a particular control chart for attribute data, namely the P chart. The following are attribute data defects, namely mushy, cracked, and crushed. P Chart of Tofu Products is presented in **Figure 6**.

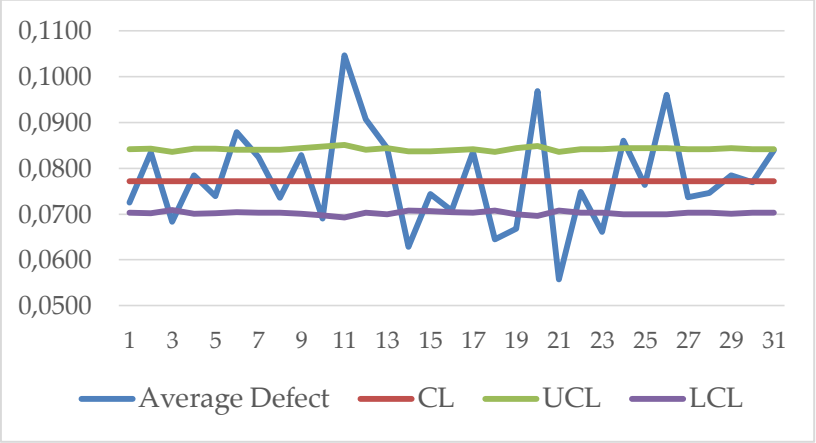

Figure 6. P Chart of Tofu Products

Figure 6 shows that tofu products have been considered outside the control limits of UCL and LCL. Where defect products that exceed UCL are the highest on days 12, 20, and 26, while defect products that exceed LCL are on days 14, 18, and 21. Further action is needed in order to maintain quality control and product improvement.

The scatter diagram illustrates two variables: the amount of tofu (X) and the number of defects (Y). The scatter diagram can be seen in **Figure 7**.

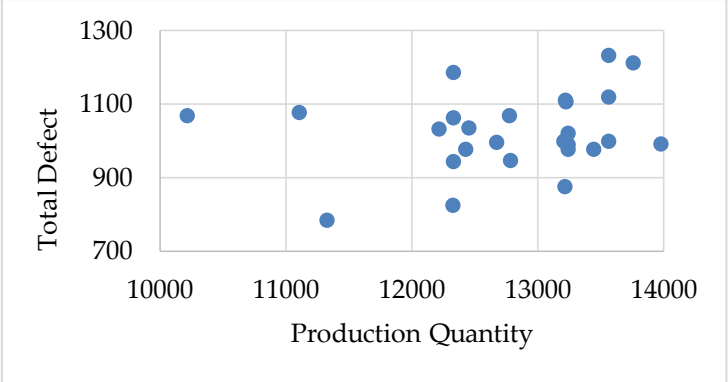

Figure 7. Scatter Diagram

The data illustrated in the scatter diagram are spread casually. Based on **Figure 7**, the X variable is the amount of tofu production. The Y variable is the defect quantity, which does not correlate.

Figure 8. The cause-effect diagram was used to analyze the causes of defects. Furthermore, 5M+E was used as the factor which caused such a defect. The Ishikawa Diagram is presented in **Figure 8**.

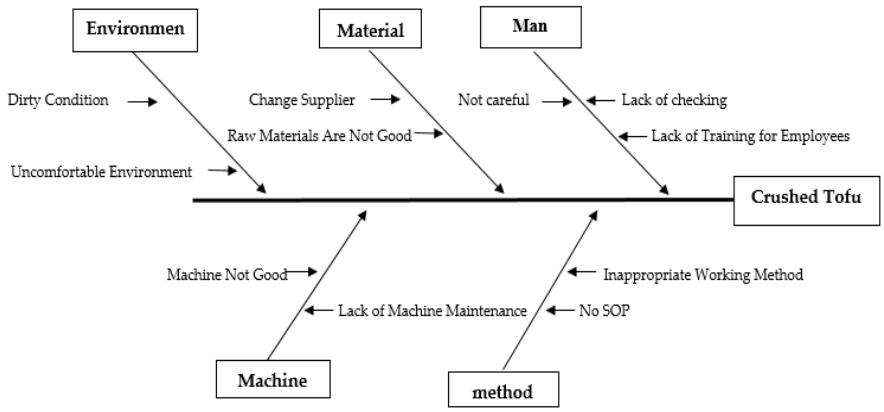

Figure 8. Ishikawa Diagram of Tofu Defect

Figure 8 shows the five identified factors that cause defects. The first factor, namely the human factor, includes a lack of employee training. The material factor is that the raw material was not good and constantly changed suppliers. The machine factor refers to the lack of maintenance.

Moreover, environmental factors include untidy and polluted workshop areas. Then, the method factor is the lack of supervision and the absence of SOPs.

The implementation of Kaizen to improve the product quality in this company used a qualitative approach. Moreover, the analysis in improving product quality used the Kaizen Five-M Checklist. The Kaizen concept proposes improvements to the causes of product defects [10]. Furthermore, integrating seven tools to identify the causes of defects and Kaizen as a method to improve product quality was expected to improve a sustainable product quality. The fishbone diagram analysis found that the product defects were caused by humans, machines, the environment, methods, and materials. Then, from the cause analysis results, a solution can be obtained using the Kaizen Five-M Checklist. Kaizen provides more attention to the process than the results [11]. Brainstorms with the owner and employees were performed to gain a better improving scenario. The results of the problem-solving analysis can be seen in Table 1.

Table 1. Results of improvement analysis with Kaizen Five-M Checklist

Factor	Problem	Proposed Solution
Method	There is no written SOP in the production process, so the production process interrupted	The need for a good understanding and the creation of clearly written SOPs so that employees can work properly and correctly.
man	Lack of work experience and job training for employees	The management performs regular training and basics of knowledge in the tofu production process. Provide a reward to workers with good performance to boost working motivation.
Machine	The condition of machines that have been around for a long time often has problems during the production process.	Regular maintenance to be conducted, machine upgrades are carried out if the machine's condition is too old and often has problems affecting product quality.
Material	The condition of the raw materials is of poor quality	It is necessary to check directly before purchasing soybeans.
Environment	The place of production is not secure, the condition of the factory is damaged, and the air circulation and lighting are lacking.	It is necessary to renovate the workshop and make additional ventilation or install a blower to help the airflow and add an additional lighting so that workers can do their jobs comfortably.

The determination plan of action using the Kaizen method was based on 5W+1H (*What*, *Why*, *Who*, *When*, and *How*) [15] [16].

Furthermore, plan improvement in tofu defects is illustrated in **Table 2**.

Table 2. Plan Improvement with 5W and 1H

No	Movement	Problem
1.	*What?*	*What is the objective of the measurement?* The measurement goal is to maintain the quality of the excellent product.
2.	*Why?*	*Why should they do repairs and countermeasures ?* Repair countermeasures because Man, Methods, Materials, Machines, and Environment are the critical success factors to gain better improvement
3.	*Who?*	*Who will carry out repairs and countermeasures?* The workers are directly responsible for the production process.
4.	*when?*	*When to overcome and repair?* Countermeasures will be done as soon as possible, hoping the workers are more skilled and improve accuracy.
5.	*Where?*	*Where will the planned activities be done?* Countermeasures will be done on the production floor with a potential defect rate.
6.	*How?*	*How is the implementation done?* a. To do control by completing any defects that occur in the production. b. The company provides directions, especially to the responsible workers who answer for product defects. c. Give the training to use upgradeability employee. d. Evaluate the quality materials for the production process. e. Control and maintenance machines are intensively done.

Table 2 shows that implementation 5W and 1H. The next stage was calculating the Five-Step Plan system based on the scenario of this table.

The Five-Step Plan was based on *Seiri, Seiton, Seiso, Seiketsu, and Shitsuke* (5S). **Figure 9** illustrates the current condition of the 5S on the tofu production floor.

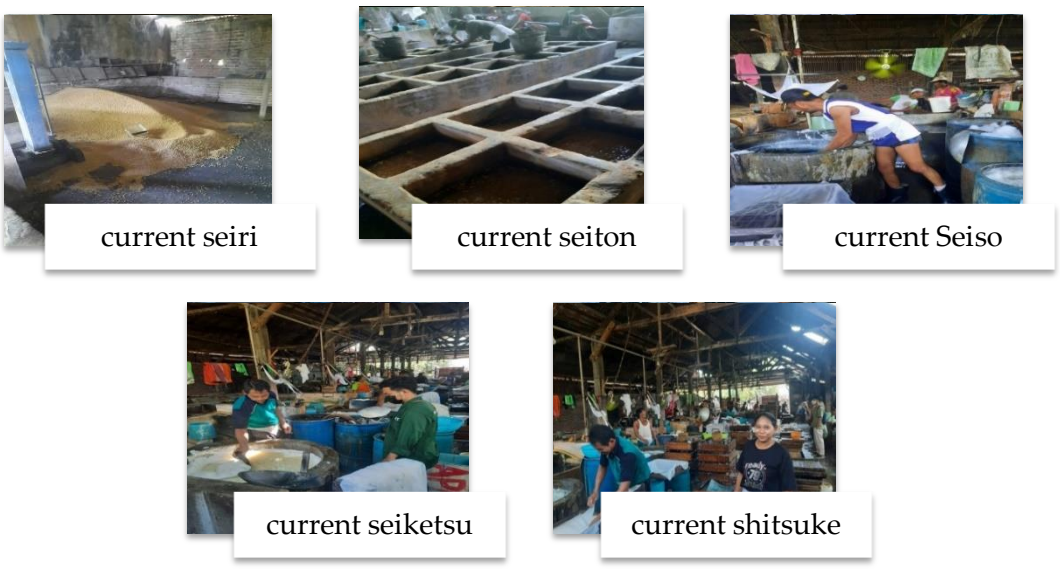

Figure 9. Current condition of 5S

Seiri refers to a situation where raw materials piled up, which caused soybean damage and contamination. As a result, workers had obstacles maintaining quality ingredients, and finally, the product did not accomplish the specification. Further plan implementation in the sorting stage includes reducing the load of raw materials and re-layout the space for raw materials to maintain the soybean quality. *Seiton* means arranging and positioning materials and goods at the right time and place. The current situation was that there was no storage for the soybeans. As a result, preparation time was inadequate and caused delays on the working process. Moreover, disorganized equipment caused delay in the work process. Seiton plan includes adopting Material Requirement Planning Method and providing extra space for equipment and tools.

Seiso means well-orderliness work environment. The current situation at the time was that there were untidiness working facilities which caused disrupting on material handling and polluted environment. The Seiso implementation plan includes providing bins and good air circulation in the working area. Seiketsu means to organize working equipment and materials. Conducting a proper Seiketsu implementation plan is related to previous action plans, including Seiri, Seiton, and Seiso. Moreover, the Seiketsu action plan includes providing SOPs and regular training to workers and relay out workshop facilities to achieve a better working environment. Shitsuke means accommodating the four previous S factors to gain better productivity in the tofu production process.

It can be concluded that based on the Seven Tools, there were three types of product defects, namely soft tofu, cracked tofu, and damaged tofu. Moreover, the primary defect was flaccid tofu , as many as 13,847 in one month of production. The Pareto diagram shows the percentage of 43.8% of the total defects. The scatter diagram of data processing shows no influence between the amount of production and the control limit. Then, from the fishbone diagram, it is revealed that human factors are the dominant factor in product defects. As a result, there are often defects in the product. However, the defects in mushy tofu were caused by an inadequate pressing process because there was no written SOP. In addition, crack and crush defects were caused by the pressing process and pressing machine.

Furthermore, improvements can be made based on Kaizen analysis, starting with creating a Standard Operating Procedure (SOP). Moreover, providing regular briefing and training to workers, performing periodic maintenance, and replacing broken spare parts can reduce the disruption of the production process. In addition, calculating the right amount when buying

the raw materials, refurbishing the workshop's layout, and providing good air ventilation and sufficient lighting to provide better working conditions can improve productivity and reduce product defects. The improvement scenario based on the implementation of Kaizen can be seen through a normalized P-Chart in **Figure 10**.

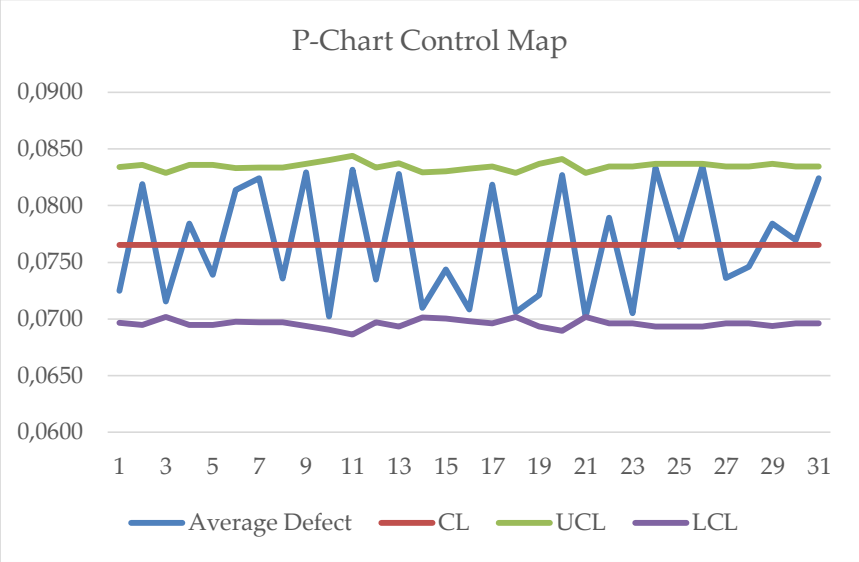

Figure 10. Normality P-Chart

Figure 10 shows that the results of normality based on the implementation of Kaizen indicate that the data obtained are entirely within the UCL and LCL control limits that have been set. The results of this study imply that product defects exceed the limits of the control chart, so it is necessary to make improvements using the Seven Tools and Kaizen analysis. The results obtained are normalization of defect data which shows the control chart is within the control limits, while the results of previous studies only obtained the results of the control chart that exceeded the limit without performing normality on the control chart.

4. Conclusion

This study found three types of defects, namely, soft, cracked, and crushed. The Seven Tools' calculation results showed 31,614 pcs tofu defects from the total production of 409.522 pcs tofu for one month. This result implies that defects can negatively impact losses and a bad reputation for the company. Moreover, this study found the highest defects, namely flaccid defects, as many as 13,847 pcs with 43.8% of the total defects. This study reveals that the defects crossed the upper control limit, so improvements were needed to make it under the control limits.

Furthermore, the fishbone diagram shows that the most dominant product defects are those caused by human factors. Suggestions for allocating with human factors are providing regular training and that a better supervision will positively impact the performance. In addition, providing manual guidance and SOPs is the better way to make improvements to sectors that require improvement.

This research pinpoints two limitations. The first limitation is related to the data collection period. The second limitation is the single implementation of the quantitative approach. Some suggestions for further research are to use Lean Six Sigma, and Human Reliability will gain comprehension approach in sustaining good quality improvement during the production process.

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