Uncovering the Secrets of High Quality Stonow Kediri Yellow Tofu with DMAIC and Supporting Technology

Kohar Sulistyadi*[1], Julianus Hutabarat[2]

[1]Postgraduate School of Communication Sciences Doctoral Program, Sahid University Jakarta, Sahid Sudirman Residence, 5th Floor. Jl. Jendral Sudirman No. 86, Jakarta, Indonesia

[2]Industrial Engineering Study Program, National Institute of Technology Malang, Jl.Sigura - Gura No.2, Sumbersari, Kec. Lowokwaru, Malang City, East Java 65152, Indonesia

kohar_sulistyadi@usahid.ac.id[1] , julianus1961@lecturer.itn.ac.id[2]*

Abstract

Wheat consumption in Indonesia is predicted to increase by 4% in 2030. Six Sigma is a complex methodology for improving production quality. Popular Yellow Tofu in Kediri has high demand, but is hampered by production capacity and production failure rates. This study increases the competitiveness of the Stonow Kediri Yellow Tofu Industry through DMAIC with a focus on sustainable quality control. An innovative approach is used to review product defects by interviewing consumers directly. Production control construction through 6M with a focus on improving worker skills, instrument calibration, tested recipes, standard procedures, data recording, and maintenance scheduling. Focus on measurable actions and targets to reduce yellow tofu product defects. This study increases the competitiveness of Stonow Kediri yellow tofu with DMAIC with optimal soybean control (histidine, 7S β-conglycinin, B1aB1bB2B3B4, multi strain fungus (Lactiplantibacillus plantarum, Meyerozyma guilliermondii) and Neurospora for taste, texture and sustainable quality control with an increase in average sigma level from 2.03 to 2.31, namely 13.8%. Significant reduction in the number of product defects from 43.48% from a capacity of 302,417 DPMO to 170,822 DPMO. The application of DMAIC in the Stonow Kediri yellow tofu industry succeeded in improving product quality and reducing the number of significant product defects. This shows that DMAIC can be an effective strategy to increase industrial competitiveness.

Key words: *DMAIC, optimal soybean control, Six Sigma, yellow tofu*

1. Introduction

Indonesia's wheat consumption is predicted to increase significantly by 4% due to industrial competition which is currently dominated by creative industries in 2030 (Widiwati et al., 2024). This power encourages global markets, national markets and markets with creative industry sectors to improve and compete to improve statistical-based integration systems in quality control, one of which is six sigma which is currently being intensively implemented in Turkey in the electronics sector in the food industry.(Ertürk et al., 2016). The contribution of six sigma cannot be separated from the integration strategy in Total Productive Maintenance (TPM) and Reliability Centered Maintenance (RCM) which succeeded in reducing planned maintenance activities by 33%, repair maintenance by 70%, cleaning duration by 50%, and increasing overall efficiency (OEE) by 20%. % and limited 260 hour factory availability case study(Shannon et al., 2023). With this combination, six sigma enters as a complex methodology to meet the market needs and expectations of stakeholders, users and human resources to improve production quality in a short time.(Pugna et al., 2016). Six sigma is increasingly developing from a continuous decision to minimize the risk of limited production technology inadequacy, increasing commitment to suppliers in all lines, uncertainty of market needs, complexity of production management and product design required, so that it has a significant impact on operational performance, especially the production of sustainable food products(Hariyani et al., 2023). Six sigma contributes fully to both large and even small industrial scales because it encourages companies to create products that have a very low chance of defects due to the contribution of controls that are implemented dynamically.(Hariyani & Mishra, 2022). With the existing combination, the application of Six Sigma will improve production quality and efficiency, encouraging the creative industry to achieve targets faster in 2030.

Apart from the contribution of wheat, one of the vegetable crops used in healthy food products is soybeans which are processed in production. One of the international products is traditional Hongjun Tofu which has a monotonous aroma and taste (only the taste of mushrooms) due to the small amount of volatile compounds (aroma producing). Compared to other fermented soybean foods, Hongjun has lower volatile compounds which impact the diversity of aroma and taste(Qiu et al., 2023). Popular Yellow Tofu in Kediri has great potential with high demand, but is hampered by limited production capacity. Industrial development needs to be designed to increase production and meet consumer demand, thereby increasing profits and economic growth(Komari et al., 2022). In January 2023, the yellow tofu industry experienced an increase in production of 15% compared to the previous year. Average daily production reaches 1500 units with processing temperatures ranging from 70-80°C. However, this increase in production was accompanied by an increase in the production failure rate of 5%. This causes losses for the yellow tofu industry. Studies in the Stonow industry experienced 3 types of defects (texture, color and taste) with sub defects of 8 types of failure in yellow tofu which occurred in the last 1 month of 2023. The causes varied, from the soybean grinding process to storage. Adapting production processes and better quality control can help reduce defects with proper control with the Six Sigma DMAIC methodology.

The implemented DMAIC study was able to increase the efficiency of the warehouse process cycle, overcome waste and increase customer satisfaction simultaneously by 70%(Adeodu et al., 2023). Not only that, the efficiency of production machine maintenance through statistical control chart capabilities, and factors that influence maintenance can be identified in detail, so that corrective steps can be obtained to reduce the duration by 20 minutes, the number of production breakdowns decreased by 2%, and increase machine availability by 2%(Antosz et al., 2022). This study contributes to the efficiency of food production waste in achieving an increase in the production process with a time duration of 479 minutes with DPMO 990(Widiwati et al., 2024). This application has proven to reduce the failure rate of car weatherproof rubber production from 5.5% to 3.08%, saving company costs IDR 15,249/month & increasing the sigma level from 3.9 to 4.45 in 3 months(Mittal et al., 2023)and the risk of error in Point-of-Care (POC) glucose measurements by identifying 29 risks in 8 key steps with an indication of achievement of 3 to 5 units in measuring instrument quality control(Vincent et al., 2021). The Six Sigma DMAIC study was successful in reducing product defects in the automated pin process in the automotive industry, increasing production and reducing costs(Costa et al., 2019)and able to identify 5 types of failure in mooncake production at a production efficiency level of 4.79%, reducing cycle time from 0.498 seconds/pcs to 0.486 seconds/pcs(Widiwati et al., 2024), thus indicating that market pressure and customer demand are more dominant(Hariyani & Mishra, 2023). Another study also contributed to reducing rejection of yellow tofu by distributors from 34% down to 18% (a 16% decrease) due to the failure of the color being faded, watery, easily crushed, sour smell and less chewy.(Indrasari et al., 2021).

Existing studies review in detail cases in the Six Sigma DMAIC methodology focusing on reducing product defects and product sustainability. However, there is no operation process chart activity as a detailed activity in Define, nor is there a control design based on actions and targets for DMAIC sustainability.

This study is based on Indrasari's findings(Indrasari et al., 2021)and collaborated with the continuous DMAIC model on control variables to support continuous improvement plans for yellow tofu production. It emphasizes human resource training(Al Ali et al., 2019; Berti et al., 2022), instrument calibration, recipe standardization(Blinnikova et al., 2020; Mohamed et al., 2024), and SOP development(Sulistiyowati et al., 2019). Data logging and preventive maintenance are implemented to optimize processes and ensure consistent quality(De Menna et al., 2018; Fentis et al., 2022). This study combines two process analysis tools, namely SIPOC (Suppliers, Inputs, Process, Outputs, Customers) and OPC (Operation Process Chart) to increase the efficiency of yellow tofu production(Alkhafaji & Al Obeidy, 2018; Daniyan et al., 2022). With detailed process mapping, correct problem identification, and effective solutions, the yellow tofu industry can increase its competitiveness and produce higher quality products to meet consumer needs. This study uses an innovative method to review yellow tofu product defects by interviewing consumers directly with individual consumers, groups and souvenir centers in Kediri, making it possible to dig deeper and understand various consumer perspectives regarding product defects due to machine facilities that fail to calibrate. appropriately(Dewanti et al., 2022). This study also uses the construction of yellow tofu production control through 6M (Manpower, Measurement, Methods, Materials, Mother Nature, Machine) with a focus on improving worker skills, instrument calibration, tested recipes, standard procedures, data recording, and maintenance scheduling.(Shannon et al., 2023). It aims to reduce production defects directly through measurable actions and targets. The uniqueness of this research lies in the dominant control of skills, instruments, recipes, procedures, recording and scheduling with actions and targets to reduce defects in yellow tofu products.

This study increases the Competitiveness of the Stonow Kediri Yellow Tofu Industry, East Java, Indonesia through DMAIC with a Focus on Sustainable Quality Control. This study specifically takes an innovative approach to reviewing yellow tofu product defects by interviewing consumers directly. Construction of yellow tofu production control through 6M with a focus on improving worker skills, instrument calibration, tested recipes, standard procedures, data recording and maintenance scheduling. Focus on measurable actions and targets to reduce yellow tofu product defects.

Increased Efficiency with SIPOC and OPC integration design helps map production processes in detail, identify potential optimization areas, and increase production efficiency. Quality Improvement with an in-depth understanding of consumer needs and production processes through consumer interviews and 6M analysis enables identification and solutions to product defects, improving the quality of yellow tofu. Increasing Competitiveness with the implementation of Six Sigma helps the Kediri yellow tofu industry produce higher quality and competitive products in the market.

Cost reduction by designing to reduce product defects and optimizing the production process through Six Sigma can save production costs significantly. Increased Consumer Satisfaction, because higher quality yellow tofu with a taste and texture that consumers like increases consumer satisfaction and loyalty. Increased profits due to increasing efficiency, quality and consumer satisfaction can increase profits for the yellow tofu industry in Kediri.

2. Research methods

2.1 Research design

The research design uses quantitative with the Six Sigma DMAIC approach (Define, Measure, Analyze, Improve and Control)(Vicente et al., 2024; Widiwati et al., 2024, 2024). This research design was chosen because of its ability to increase the efficiency, quality and competitiveness of the Kediri yellow tofu industry, which will ultimately increase profits for the Stonow Kediri yellow tofu industry.

2.2 Research Instrument

The instrument used was a voice of customer based interview to obtain the variable defects of Stonow Kediri's yellow tofu product with the target variables being texture defects, color defects, dirt defects and taste defects with similarities in the perceptions of 10 selected respondents.(Indrasari et al., 2021). The second instrument is to carry out observations at the research location, namely the Tofu Stonow Industry which is located on Jl. Tinalan, RT 3, RW 4, Kec. Islamic boarding school, Kediri city, East Java from 13 February 2023 to 13 March 2024 to ensure the correctness of critical to quality variables, identify the preparation of supplier descriptions, main materials for the production input process, identify operations with activity duration, activity models and information arranged on the SIPOC diagram by continuing with output and consumer activities involved both individually and in groups.

The third instrument is to measure the percentage of product defects using a p-chart to measure existing targets achieved over 12 months which are used to identify the level of opportunity for defects in yellow tofu products with the sigma value perspective achieved over 12 months.(Daniyan et al., 2022). The fourth instrument is designing a Pareto diagram to determine the highest to lowest level of defect in the tofu product and designing a fishbone diagram as a solution to product defects.

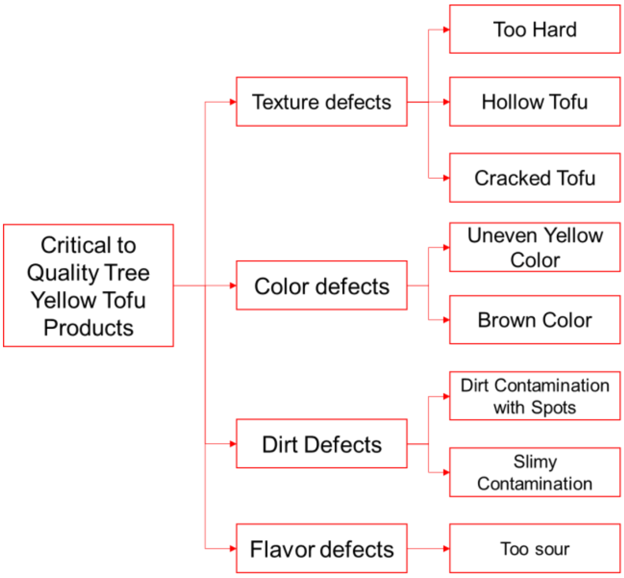
2.3 Research procedure

This research procedure uses the Critical to Quality Tree (CTQ Tree) activity to identify the critical characteristics of yellow tofu products expected by customers.(Arifin et al., 2021). SIPOC integrated Operation Process Chart (OPC) to map the yellow tofu production process in detail and identify areas that have the potential to experience defects(Daniyan et al., 2022). P-Chart to monitor the stability of the production process and identify variations in defect rates. Defects Per Million Opportunities (DPMO) to calculate the level of defects in the production process(Sucipto et al., 2020). Pareto diagram to identify the most frequently occurring types of defects(Daniyan et al., 2022). Cause and Effect Diagram (Fishbone Diagram) to identify the root causes of product defects. Design Control to implement control measures to ensure consistent product quality. This procedure in Six Sigma contributes to the Stonow yellow tofu producers in improving the quality of their products and meeting customer needs(Widiwati et al., 2024). By identifying the root causes of defects and implementing appropriate solutions, manufacturers can improve the efficiency and effectiveness of production processes, as well as increase customer satisfaction and company profits.

3. Results and Discussion

3.1 Define

3.1.1 Critical to Quality Tree



Figures1. Critical to Quality Tree Yellow Tofu Products

Source: observation data, 2022

Defects in yellow tofu products based on voice of customer (VOC) indicate several problems that need to be paid attention to by producers. VoC for yellow tofu product defects includes:

a Texture defects, namely too hard, because this problem may be caused by an incorrect soybean grinding process or a tofu making process that takes too long. A consistency that is too hard can make the eating experience unpleasant for consumers. Hollow Tofu, caused by several factors, including poor soybean quality or deficiencies in the tofu formation process. Hollow tofu not only gives the impression of lower quality but can also affect the taste and texture. Cracked Tofu, cracks in tofu can be caused by improper processing or use of inappropriate ingredients. This can also be a sign that the tofu is not firm enough or not bound enough.

b Color defects with an uneven yellow color are caused by differences in the manufacturing process or the use of non-uniform materials. Uneven color can give the impression that the tofu was not processed properly. The brownish brown color of tofu can be an indication that the tofu is no longer fresh or has been stored for too long. This can also be caused by an improper manufacturing process.

c Dirt Defects, with contamination with Stains, as this can be caused by unhygienic production processes or improper storage. Stains on tofu can reduce its quality and safety. Slimy Contamination: Slimy contamination of tofu can be a sign that the tofu was not stored properly after production or was exposed to excessive moisture.

d Flavor defects, because it is too sour (Too Sour), because this could be an indication that the tofu fermentation process was not carried out properly or that the soybeans used were not fresh. A taste that is too sour will not be liked by consumers. In overcoming these defects, manufacturers must pay attention to the production process from start to finish, including the selection of raw materials, manufacturing processes and storage conditions. Proper adjustments in production processes and improvements in quality control can help reduce defects submitted by customers. Additionally, regularly listening to customer feedback will help manufacturers to continuously improve the quality of their products.

3.1.2 DPMO Existing Conditions

Table1. 3 DPMO Existing Conditions

Month-	Production (units)	Number of Defects	DPMO	Sigma
1	350,000	102,200	292,000	2.05
2	350,000	60,200	172,000	2.45
3	350,000	67,200	192,000	2.37
4	350,000	108,500	310,000	2.00
5	350,000	139,300	398,000	1.76
6	350,000	125,300	358,000	1.86
7	350,000	125,650	359,000	1.86
8	350,000	135,100	386,000	1.79
9	350,000	105,350	301,000	2.02
10	350,000	112,350	321,000	1.96
11	350,000	69,650	199,000	2.35
12	350,000	119,350	341,000	1.91
Amount	4,200,000	1,270,150	3,629,000	24.4
Average	350,000	105,846	302,417	2.03

Source: data, 2022

Even though Stonow Kediri's yellow tofu production is quite stable, the average sigma level of 2.03 shows that the production process still has many defects. Fluctuations in DPMO and sigma values every month indicate that the process is not optimal (Table 1).

Month 5 was the worst month with 398,000 defects per million opportunities, while month 11 performed best with 199,000 defects.

3.1.3 SIPOC integrated Operation Process Chart

SIPOC's integrated Operation Process Chart is to increase process efficiency and effectiveness, as well as improve the quality of yellow tofu products by knowing in depth the production process through suppliers, inputs, operation process charts, output and customers.

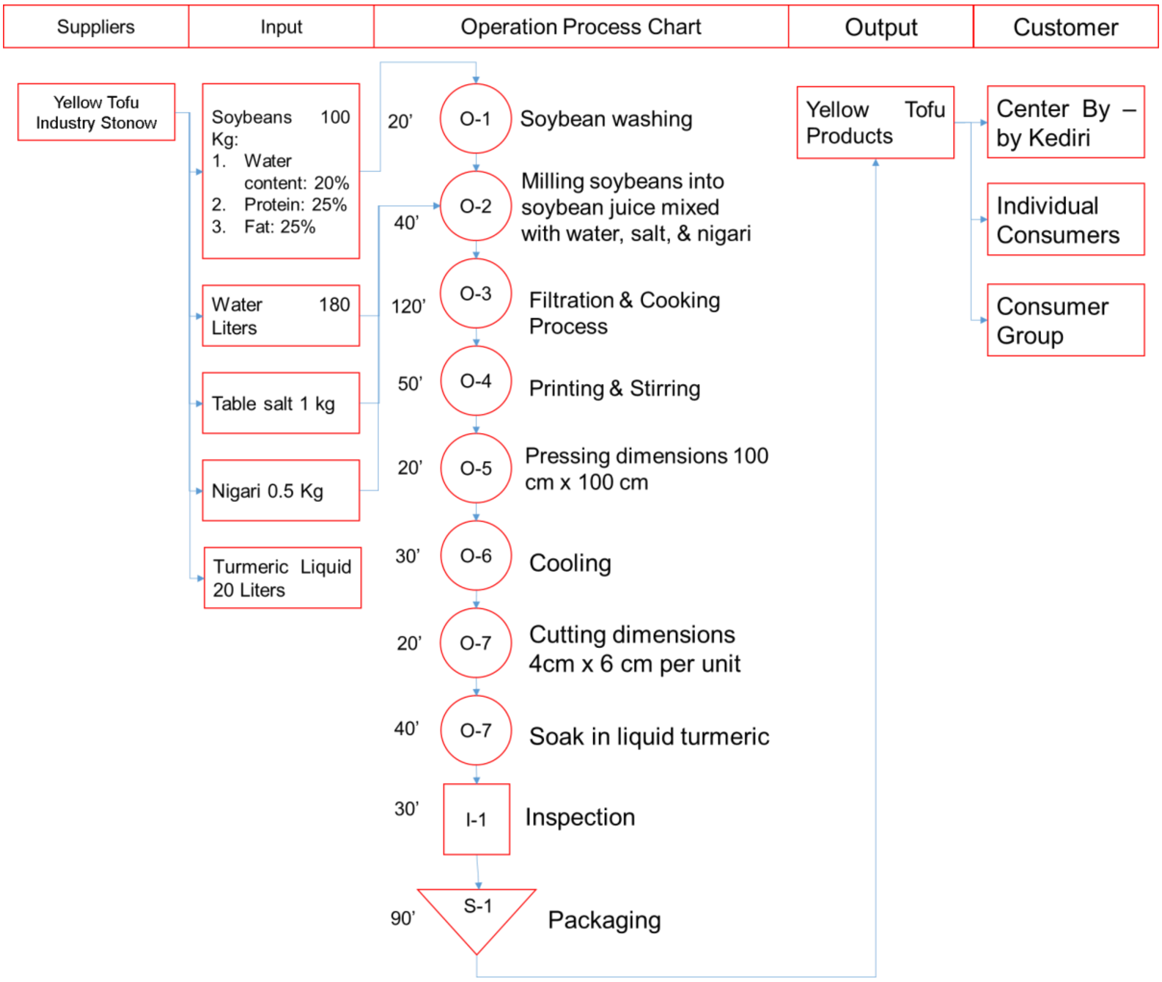


Figure 2. Operation process chart integration SIPOC diagram

Operation process chart integration SIPOC diagram with the main supplier component being the yellow tofu industry which provides soybean products as the main raw material (Figure 2). The inputs required for the yellow tofu production process include soybeans with a water content of 20%, 25% protein and 25% fat, 180 liters of water, 1 kg of table salt, 0.5 kg of nigari and 20 liters of liquid turmeric. The operation process begins with washing the soybeans for 20 minutes, followed by grinding the soybeans into soybean juice mixed with water, salt and nigari for 40 minutes. Then, the filtration and cooking process was carried out for 120 minutes, followed by molding and stirring for 50 minutes. The next process is pressing with dimensions of 100 cm x 100 cm for 20 minutes, followed by cooling for 30 minutes.

After cooling, the tofu is cut into sizes of 4 cm x 6 cm per unit, and soaked in a liquid turmeric solution for 30 minutes. In the final stage, the tofu product is packaged for 90 minutes before being sent to the customer. The output of this process is a yellow tofu product that is ready to be sent to customers, including the Kediri souvenir center, individual consumers and group consumers. Thus, this process involves a series of steps from start to finish to produce quality yellow tofu products for customers.

3.2 Measure

3.2.1 P-Chart

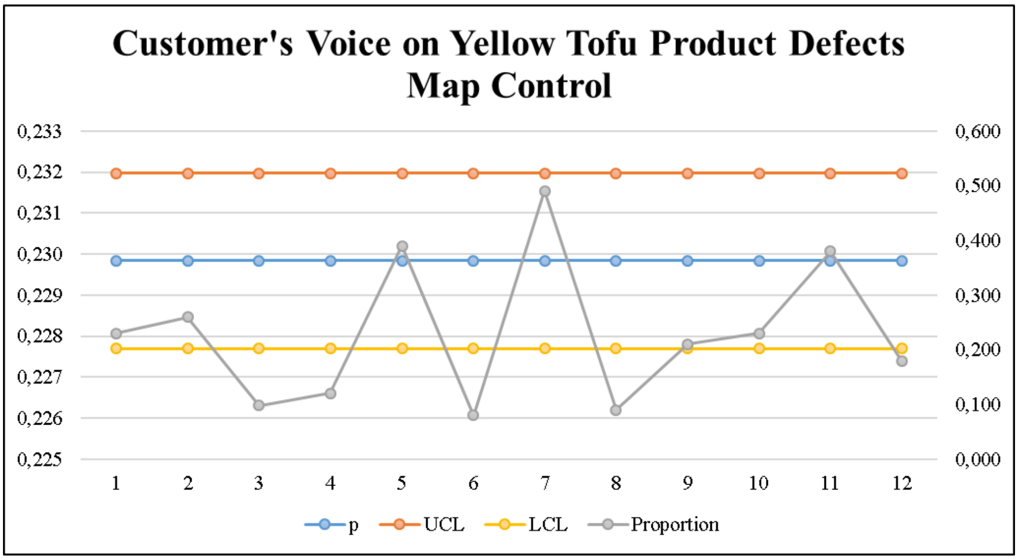
Table2. p-Chart Product Know

Month-	Production (units)	%Defects of Yellow Tofu Products	Number of Defects	%Proportion	elementary school	p	UCL	LCL
1	350,000	23%	80,500	0.230	0.0004	0.230	0.232	0.228
2	350,000	26%	91,000	0.260	0.0004	0.230	0.232	0.228
3	350,000	10%	34,300	0.098	0.0004	0.230	0.232	0.228
4	350,000	12%	42,000	0.120	0.0004	0.230	0.232	0.228
5	350,000	39%	136,500	0.390	0.0004	0.230	0.232	0.228
6	350,000	8%	28,000	0.080	0.0004	0.230	0.232	0.228
7	350,000	49%	171,500	0.490	0.0004	0.230	0.232	0.228
8	350,000	9%	31,500	0.090	0.0004	0.230	0.232	0.228
9	350,000	21%	73,500	0.210	0.0004	0.230	0.232	0.228
10	350,000	23%	80,500	0.230	0.0004	0.230	0.232	0.228
11	350,000	38%	133,000	0.380	0.0004	0.230	0.232	0.228
12	350,000	18%	63,000	0.180	0.0004	0.230	0.232	0.228
Amount	4,200,000		965,300	2,758	0.0051	2,758	2.7836	2.7324
Average	350,000		80,442	0.230	0,000	0.230	0.232	0.228

Source: data processing, 2022

Yellow tofu production data for 12 months, with total production of 4,200,000 units and average production of 350,000 units per month, has measured the percentage of defects in yellow tofu products. The results show variations in the percentage of defects each month. In the first month, the defect percentage reached 23%, followed by 26% in the second month, and so on. The total number of defects recorded during this period was 965,300 defects, with an average of 80,442 defects per month. The total standard deviation in the number of defects is 0.0051, while the average standard deviation per month is 0.0004.

To control production quality more effectively, a P-chart has been created with a UCL (Upper Control Limit) value of 2.7836 and an LCL (Lower Control Limit) of 2.7324. The overall P-chart value is 2.758, with a monthly average of 0.230. This helps in identifying whether yellow tofu production is within acceptable control limits. Thus, manufacturers can take appropriate corrective or preventive actions if there are deviations from the established quality standards.



Figures3. Customer's Voice on Yellow Tofu Product Defect Map Control

Analysis of yellow tofu product defect control based on customer votes shows that out of a total of 12 months, there were 5 months where the number of product defects exceeded the specified control limits (Figure 3). These months are the 3rd, 4th, 6th, 8th and 12th months. This indicates a consistency problem in the production process during that period. Periods where product defects exceed control limits should be paid special attention to by the quality management team to identify the cause and take appropriate corrective action. Thus, improvements in production processes and quality control can be implemented to ensure consistency and better product quality in the future.

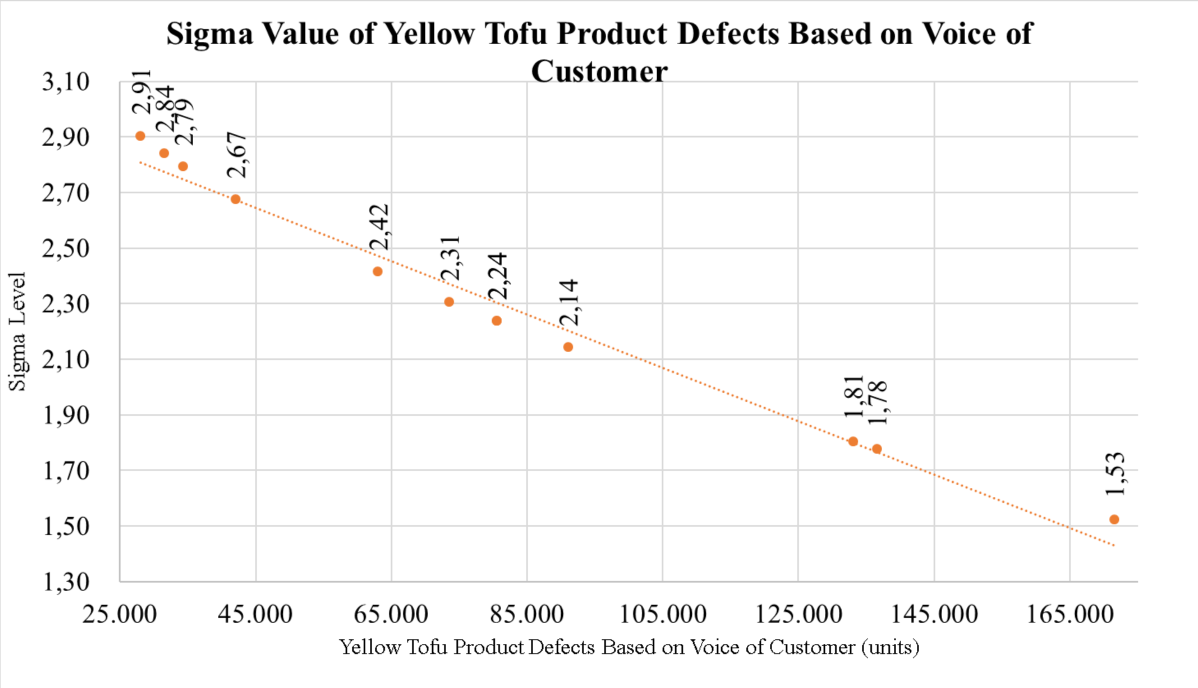
3.2.2 DPMO

Table3. DPMO Yellow Tofu Products

Month-	Production (units)	Number of Defects	DPMO	Sigma
1	350,000	80,500	230,000	2.24
2	350,000	91,000	260,000	2.14
3	350,000	34,300	98,000	2.79
4	350,000	42,000	120,000	2.67
5	350,000	136,500	390,000	1.78
6	350,000	28,000	80,000	2.91
7	350,000	171,500	490,000	1.53
8	350,000	31,500	90,000	2.84
9	350,000	73,500	210,000	2.31
10	350,000	80,500	230,000	2.24
11	350,000	133,000	380,000	1.81
12	350,000	63,000	180,000	2.42
Amount	4,200,000	965,300	2,758,000	27.7
Average	350,000	80,442	229,833	2.31

Source: data processing, 2022

Defects Per Million Opportunities (DPMO) for yellow tofu products, the results show that there are a total of 2,758,000 defects in million opportunities (Table 3). The average DPMO per month is 22,833, with a sigma number of 27.7 and an average sigma per month of 2.31. Thus, it can be concluded that the level of defects in the production process of yellow tofu products tends to be high, considering the significant number of DPMOs. Although the average monthly sigma is 2.31, which indicates an acceptable level of performance in the production process, there is still room for improvement. Manufacturers need to conduct a thorough evaluation of their production processes, identify the sources of defects, and implement necessary corrective actions to reduce the number of defects and improve overall product quality. Thus, stricter quality control and continuous improvement in production processes can help reduce defect rates and increase customer satisfaction.



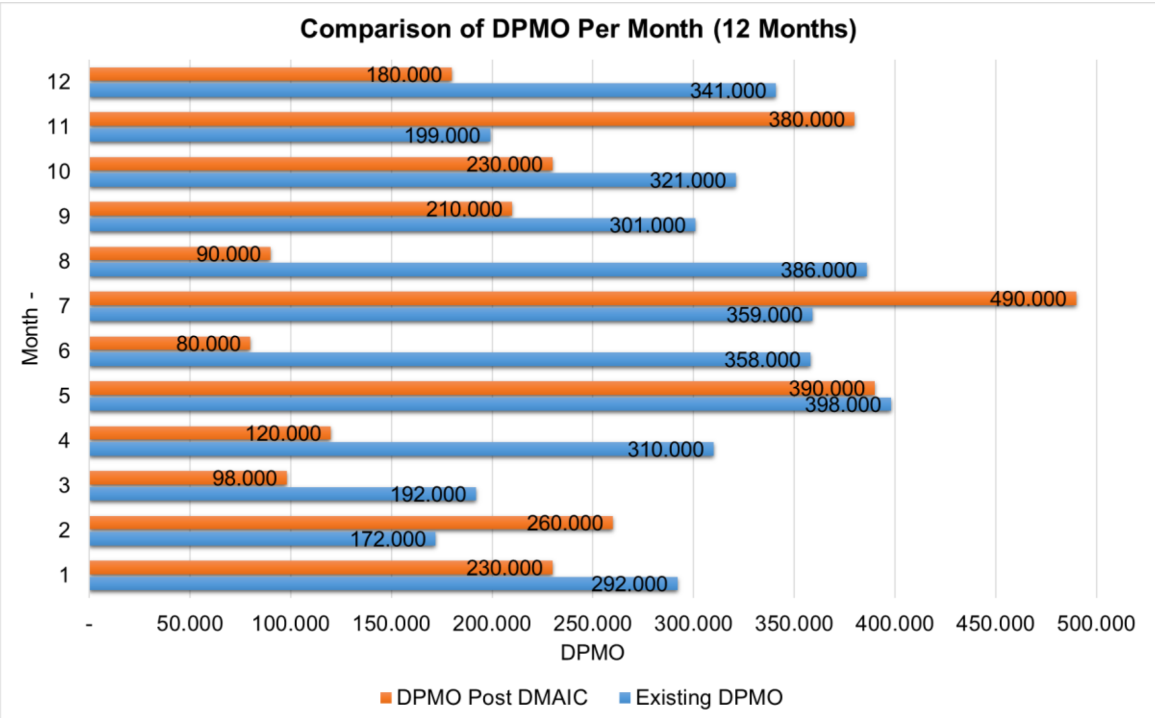
Figures4. Sigma value of yellow tofu product defects

Sigma value of yellow tofu product defects, which is based on voice of customer, found that the highest sigma level value was 2.91, while the lowest sigma level was 1.53 (Figure 4). The sigma level value is an indicator of the level of defects in the production process. The higher the sigma level value, the lower the level of defects in the product. With the highest sigma level of 2.91, this shows that the production process has a relatively low level of defects, although there is still room for improvement in reducing product defects. However, the lowest sigma level of 1.53 indicates that there are several defects that need to be addressed immediately in the production process to improve quality and customer satisfaction. Therefore, companies need to carry out a thorough evaluation of the production process and implement the necessary improvements to increase the overall sigma level value. Thus, increasing the sigma level value can help improve the quality of yellow tofu products and minimize defects felt by customers.

Table4. Comparison of Sigma Level and Average Per Month (12 Months)

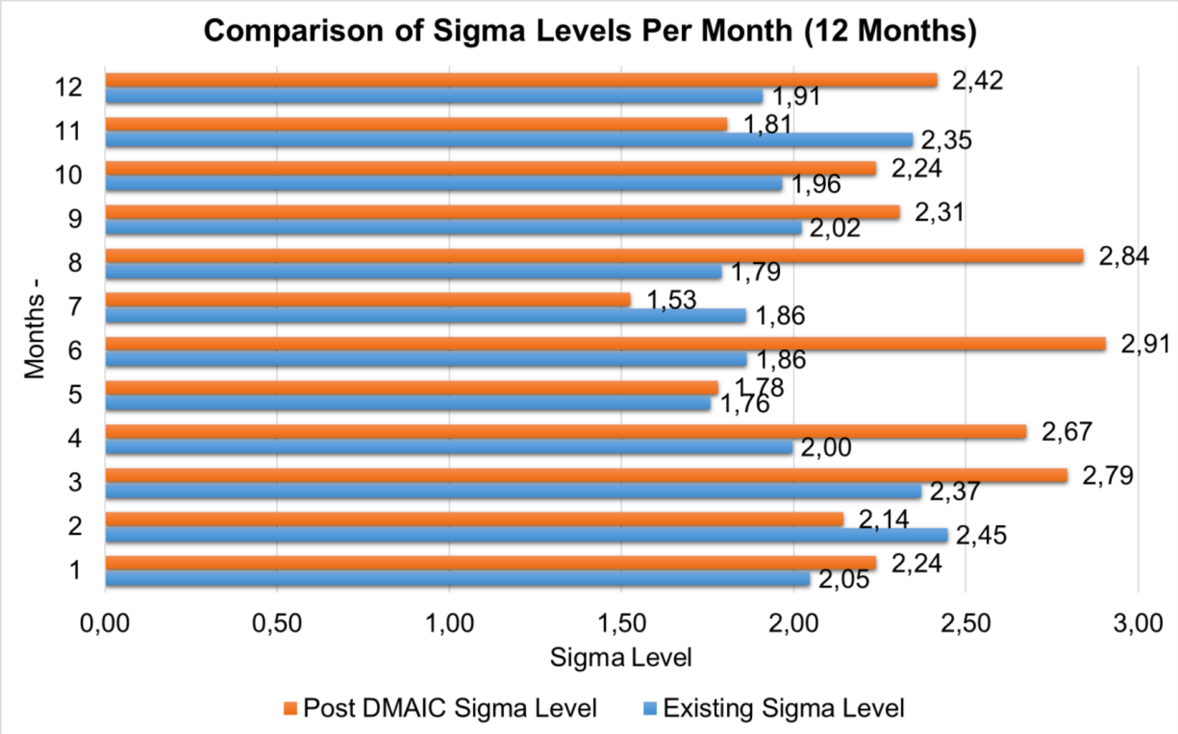
Month -	Existing DPMO	DPMO Post DMAIC	Existing Sigma Level	Post DMAIC Sigma Level
1	292,000	230,000	2.05	2.24
2	172,000	260,000	2.45	2.14
3	192,000	98,000	2.37	2.79
4	310,000	120,000	2.00	2.67
5	398,000	390,000	1.76	1.78
6	358,000	80,000	1.86	2.91
7	359,000	490,000	1.86	1.53
8	386,000	90,000	1.79	2.84
9	301,000	210,000	2.02	2.31
10	321,000	230,000	1.96	2.24
11	199,000	380,000	2.35	1.81
12	341,000	180,000	1.91	2.42
Amount	3,629,000	2,758,000	24.37	27.67
Average	302,417	229,833	2.03	2.31

Source: data processing, 2022



Figures5. Comparison of DPMO Per Month

The application of DMAIC in the Stonow Kediri yellow tofu industry resulted in a significant reduction in product defects (Figure 5). The number of product defects fell from 302,417 DPMO to 170,822 DPMO. (Reduction in product defects / Initial product defects) x 100%, namely (131,595 / 302,417) x 100% = 43.48%

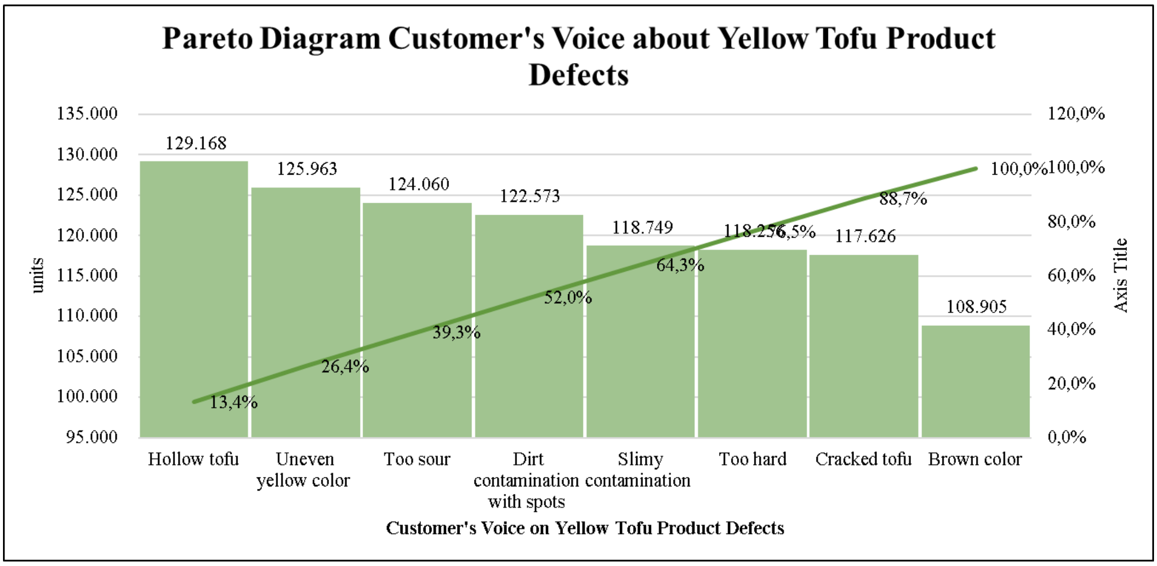


Figures6. Comparison of Sigma Levels Per Month (12 Months)

The largest increase in sigma value occurred in month 6 (from 1.86 to 2.91) and month 8 (from 1.79 to 2.84) (Figure 6). The decrease in sigma value occurred in month 5 (from 1.76 to 1.78) and month 7 (from 1.86 to 1.53). The sigma level with production capacity between existing conditions and post-repair measurement conditions succeeded in improving the quality of the Stonow Kediri yellow tofu production process, with the average sigma value increasing from 2.03 to 2.31. Percentage Increase = [(2.31 - 2.03) / 2.03] x 100% equals 13.8%. An increase in the sigma level of 13.8% shows a significant increase in the quality of the production process.

3.3 Analyze

3.3.1 Pareto Chart

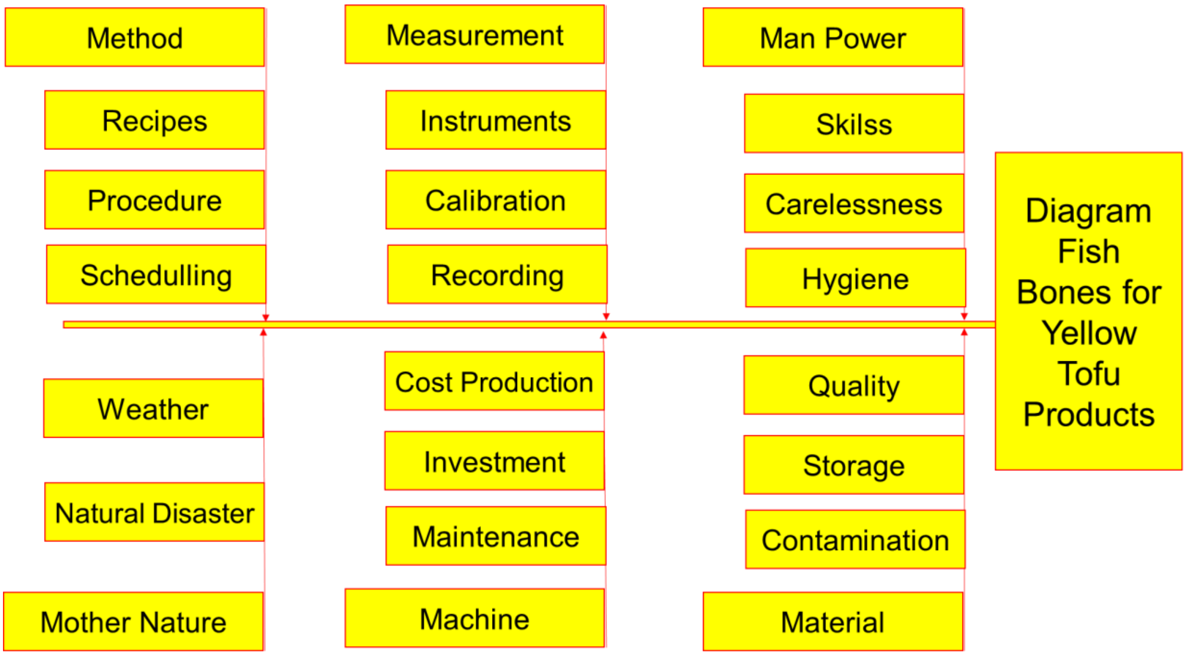


Figures7. Pareto Diagram Customer's Voice about Yellow Tofu Product Defect

The Pareto diagram shows that in yellow tofu products, the largest type of defect is "Hollow Tofu", which causes 129,168 units of defective products (Figure 7). This suggests that problems with hollow tofu consistency have a significant impact on overall product quality. On the other hand, "Brown Color" is the lowest type of defect with only 108,905 defective product units. Even though the numbers are lower, it is still important to pay attention to these issues to ensure the product has a consistent appearance and is attractive to consumers. By focusing on solving the "Hollow Tofu" problem, manufacturers can significantly improve the quality of their products and minimize the number of defective products produced.

3.3.2 Cause – Effect Diagram

The cause and effect diagram for yellow tofu product defects reflects the relationship between various factors in the production process and the final quality of the product (Figure 8). At the production method level, success depends on the recipe used, procedures followed, and production scheduling.



Figures8. Fishbone Diagram for Yellow Todu Products

Changes in any of these may affect overall product quality. Product quality measurements are represented by the instruments used, instrument calibration, and accurate data recording. The quality of the workforce is also an important factor, where skill, carelessness and hygiene play a role in maintaining hygiene standards and product quality. Natural factors, such as natural disasters and weather, can also affect the production process and final product quality. The machines used require proper maintenance and sufficient investment to ensure consistency in production and control production costs. Finally, raw materials play an important role in product quality, with good storage and prevention of contamination being determining factors. By understanding the relationship between all of these factors, manufacturers can identify weak points in their production processes and take steps to improve overall product quality.

3.4 Improvements

Development of Solutions from Cause - Effect Diagrams using 6M-based improvements based on fishbone diagrams. Fishbone diagram 6M finds the following identification.

Table 5. Development of Solutions from Cause - Effect Diagrams using 6M-based improvements based on fishbone diagrams.

6M	Manpower	Measurements	Methods
1.	**Skills**	**Instruments**	**Recipes**
a	Training on the process of making yellow tofu, including milling, molding, cooking, and packaging.	Thermometers to measure water temperature and soybeans need calibration	Use of raw and tested recipes
b	Competency tests to ensure workers have adequate knowledge and skills.	Stopwatch for measuring grinding, printing and cooking times is not appropriate	Adjustment of recipes according to the condition of raw materials and equipment.
c		Scales for measuring raw materials have not been calibrated in the last 3 months	
d		pH meter to measure the acidity level of tofu has not been calibrated in the last 3 months	
2.	**Carelessness**	**Calibration**	**Procedure**
a	Implementation of strict standard operating procedures (SOPs) to minimize errors.	Calibrate measuring instruments periodically every 3 months, in accordance with applicable standards.	Development and implementation of SOPs for all yellow tofu making processes.
b	Supervision and monitoring carried out by supervisors or quality control (QC).	Recording of calibration results and corrective actions taken for soybean capacity measurement	Clear and easy-to-understand SOP documentation.
3.	**Hygiene**	**Recording**	**Scheduling**
a	Application of 5S programs (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) in the work environment.	Recording process data and production results, such as temperature, time, and raw materials needs to be done for precise raw time predictions	Regular equipment maintenance and cleaning schedules.

b	Use of appropriate personal protective equipment (PPE) by workers.	Data analysis to identify and address problems during yellow tofu production	The use of spare parts that are original and in accordance with standards.
6M	**Materials**	**Mother Nature**	**Machine**
4.	**Quality**	**Weather**	**Production Costs**
a	The use of quality soybeans, such as high-yielding varieties of soybeans that are free from pests and diseases.	Regulation of production processes to adapt to extreme weather.	Accurate and efficient calculation of production costs.
b	Inspection of raw materials before use.	The use of assistive devices such as fans or air conditioners to control temperature.	
5.	**Storage**	**Natural disasters**	**Investment**
a	Storage of raw materials in a dry, cool place, and avoid contamination.	Implementation of disaster mitigation systems to minimize the impact of natural disasters.	Investment in more modern equipment and technology to improve production efficiency and quality.
b	Application of first-in-first-out (FIFO) system for raw material rotation.	Have insurance to protect assets and production.	
6.	**Contamination**		**Maintenance**
a	Implementation of HACCP (Hazard Analysis and Critical Control Points) program to prevent contamination of raw materials.		Sufficient budget allocation for maintenance and repair of production equipment.
b	Regular testing of raw materials to ensure their safety and quality.		

Source: Focus Group Discussion, 2022

To address the problems identified in the cause-and-effect diagram, solution development steps have been designed for each affected area (Table 5). First, in terms of manpower, adequate training on the process of making yellow tofu will be given to employees, including lessons on milling, forming, baking and packing. Competency tests will also be conducted to ensure sufficient knowledge and skills. In addition, strict standard operating procedures (SOP) will be implemented to reduce errors, while supervision and monitoring will be carried out by supervisors or quality control. In terms of hygiene, the 5S program will be implemented in the work environment, while workers will use appropriate personal protective equipment (PPE). In the field of instrument measurement, measurement instruments will be calibrated periodically every 3 months according to applicable standards, and the results of the calibration and corrective actions will be recorded. In addition, production process and yield data will be recorded to enable accurate time predictions, and data analysis will be carried out to identify and resolve problems during yellow tofu production. In terms of methods, tested recipes will be used, and clear SOPs will be developed and implemented for all yellow tofu making processes. Regular equipment maintenance and cleaning will also be scheduled, and genuine spare parts will be used according to standards. In terms of ingredients, high-quality soybeans will be used after inspection, and storage of raw materials will be carried out carefully to avoid contamination. A HACCP program will be implemented to prevent contamination of raw materials, while production process settings will be adapted to extreme weather conditions. Disaster mitigation systems will be implemented to minimize the impact of natural disasters, and insurance will be purchased to protect assets and production. In the field of machinery, production cost calculations will be carried out accurately and efficiently, and investments in more modern equipment and technology will be made to improve production efficiency and quality. Sufficient budget will be allocated for maintenance and repair of production equipment. With the implementation of these solutions, it is hoped that the defects identified in VOCs can be overcome and the quality of yellow tofu products can be improved.

3.5 Controls

Control activities based on the results of improvements in yellow tofu production in Kediri. This stage focuses on skills, instruments, recipes, procedures, recording, and scheduling. These six focuses have the following actions and targets that must be achieved.

Table6. Control Design in Six Sigma

Controls	Skills	Instruments	Recipes
Action	Conduct regular training programs (at least quarterly) on the entire yellow tofu making process, including milling (standardized duration: 15 minutes per batch), molding (standardized duration: 10 minutes per batch), cooking (standardized duration: 30 minutes per batch) , and packaging.	Establish a calibration schedule (every 3 months) for all measuring instruments, including thermometers (for water and soybeans) and stopwatches (for grinding, molding, and cooking). Ensure proper documentation of calibration results and any corrective actions taken.	Standardize the raw material recipe based on quality and quantity. Regularly review and adjust the recipe (at least monthly) to account for variations in raw materials and equipment performance.
Target	All production personnel must achieve competency as measured by practical skills tests.	All measuring instruments must be accurate and within the manufacturer's recommended calibration tolerances.	Achieve consistent product quality through a well-defined and adaptable recipe.

Controls	Procedure	Recording	Scheduling
Action	Develop and implement detailed SOPs (Standard Operating Procedures) for all stages of yellow tofu production. These SOPs should clearly outline each step, including time standards for critical processes.	Implement a comprehensive data recording system to capture process data (temperature, time) and production results (yield, quality). Analyze this data regularly (weekly) to identify trends and potential areas for improvement.	Establish a preventative maintenance schedule (eg, monthly cleaning, bi-annual overhaul) for all production equipment. Ensure spare parts are readily available to minimize downtime.
Target	Ensure all production staff follow consistent and documented procedures for every aspect of yellow tofu making.	Utilize data to optimize production processes, predict raw material needs, and identify root causes of defects.	Maintain equipment in optimal condition to prevent unexpected breakdowns and ensure consistent production quality.

Source: Focus Group Discussion, 2022

The increase in the average sigma level from 2.03 to 2.31 shows that the implementation of DMAIC has succeeded in improving the quality of the Stonow Kediri yellow tofu production process (Table 6). This means the number of product defects has decreased significantly, from 302,417 DPMO to 170,822 DPMO. To ensure consistent quality of yellow tofu products and minimize defects that have been identified through customer voice, a structured series of control measures is required. This includes regular training, instrument setup, recipe standardization, development of standard operating procedures (SOPs), data recording, and preventative maintenance schedules for production equipment. First, regular training (at least every quarter) must be carried out on the entire process of making yellow tofu, including grinding, forming, cooking, and packaging. Every production personnel must achieve competency which is measured through practical skills tests. Second, instrument setup should be done by establishing a calibration schedule (every 3 months) for all measurement instruments, including thermometers (for water and soybeans) and stopwatches (for grinding, forming, and cooking). Proper documentation of calibration results and corrective actions taken must be ensured. Third, the recipe for raw materials must be adjusted to the quality and quantity. Regular (at least monthly) revisions and adjustments to recipes should be made to account for variations in raw materials and equipment performance. Fourth, standard operating procedures (SOP) must be developed and implemented for all stages of yellow tofu production. SOPs should outline each step, including time standards for critical processes. Fifth, implement a comprehensive data recording system to capture process data (temperature, time) and production results (yield, quality). Regular (weekly) data analysis should be performed to identify trends and potential areas for improvement. Lastly, a preventive maintenance schedule must be established for all production equipment. Spare parts must be well stocked to minimize downtime and ensure consistent production quality. The implementation of structured quality control measures, along with regular training and preventive maintenance, will help Stonow

Kediri achieve and maintain high sigma levels. This will produce high quality yellow tofu with minimal defects, increasing Stonow Kediri's competitiveness in the market.

3.6 Discussion

Producers need to pay attention to the production process, raw materials and storage to improve the quality of yellow tofu. First, you need to understand that the quality of soybean seeds with certain histidine, 7S β-conglycinin, and B1aB1bB2B3B4 content requires less MgCl2 coagulant. On the other hand, high lysine content requires more coagulant(Chen et al., 2024). This requires creating an efficient peanut tofu production process (53.8% faster) and selecting the 7 best peanut varieties from 26 varieties to produce optimal quality tofu (CHEN et al., 2020). This is to obtain important customer feedback to help manufacturers improve product quality. Hard texture (milling of soybeans/long manufacturing process), hollow (quality of soybeans/forming), with a detailed process that will produce whole soybean tofu using a machine capable of high-speed crushing and calcium sulfate as an agglomerator, producing a more diverse taste, chewy texture, and color closer to soybeans(Lu et al., 2022). Cracks occur (processing/raw materials), resulting in uneven yellow (process/raw materials), brown (not fresh/improper processing) and stains (hygienic/storage), slimy (storage/humidity) and too sour taste (fermentation). /soybeans are not fresh). From the role of taste, it is necessary to add multi-strain mushroom material (Lactiplantibacillus plantarum and Meyerozyma guilliermondii) which contributes to the taste of tofu and combines with Neurospora (from nutty to fruity, mushroom, floral and nutty) without excessive sour and bitter tastes.(Qiu et al., 2023). Not only that, the experimental design by adding artificial Mucor plasmaticus to Mao-tofu (CC) increased the essential amino acid (EAA) and umami content compared to natural fermentation (MM). GC-MS/MS analysis showed an increase in esters (good taste) and a decrease in bad odor (sulfur compounds) in CC(Guan et al., 2024). Not only with bacterial material, the contribution of double ultrasonic waves (40 + 20 kHz) with a 30° angle as the best treatment for tofu gel significantly improves the taste, forms a dense network, and increases the hardness and water content of finished tofu.(Zhang et al., 2022). Furthermore, continuous ultrasonic waves using the ultrasonic thawing frozen tofu (UWT) process effectively shortened the thawing time (30.9-53.5%) and maintained the quality of the tofu gel. UWT 100-200 W makes the tofu protein tissue tighter and denser, and increases the ability to hold water(Lei et al., 2023). From the yellow tofu production process, it is necessary to ferment the soybean milling process which produces liquid tofu which is ready to be stirred for the solidification process, with temperatures (25°C, 37°C, and natural temperature) that influence the bacteria, aroma, and taste and natural temperature (25 -37°C) which produces better tasting liquid soybeans and chewier tofu(Dai et al., 2023), the production process will produce a residue called tofu dregs. This requires treating the tofu dregs so that it is sustainable by fermentation using Bifidobacterium longum subsp. longum BB536 thereby creating a new superior functional drink product with high levels of acetic & lactic acid, vitamin B12, iron & potassium, as well as reducing unpleasant odors from production residues(Review et al., 2023). From the creation of this beverage product, on the other hand, tofu waste (tofu whey) can be used using an electrodialysis process to increase protein yield by up to 20% without reducing the purity of the protein which is used as livestock feed.(Gagnon et al., 2023). The integrated yellow tofu production process with the SIPOC diagram produces quality tofu for customers, with inputs of soybeans, water, salt, nigari and liquid turmeric, through washing, grinding, mixing, filtration, cooking, molding, pressing, cooling, cutting, soaking and packaging, producing yellow tofu output ready to be sent to souvenir centers, individual consumers and group consumers.

12 months of production (4,200,000 units, average 350,000/month), there are variations in the percentage of defects (23%-26%). Total defects were 965,300 (average 80,442/month) with a standard deviation of 0.0051 (average 0.0004/month). A P-chart was created with a UCL of 2.7836, an LCL of 2.7324, and a P-chart value of 2.758 (average 0.230/month) to aid quality control and identification of deviations from standards. The defect rate for yellow tofu products is high (2,758,000 DPMO), although the average sigma of 2.31 is an increase from the existing sigma level of 2.03 indicating acceptable performance with an increase of 13.8%, there is still room for improvement with a more efficient DPMO of 43 .48%. Thorough evaluation and corrective action is necessary to improve quality and customer satisfaction. This framework has proven effective in increasing the Sustainability Index from 88.78% to 93.80% in the Agro-Food industry, while especially the yellow tofu industry in Kediri in the range of 2,758,000 DPMO(Main & Abirfatin, 2023). DPMO's potential in Lean Six Sigma in the energy sector is effective in increasing service realization from 2.6% to 20% in 3 months, showing its potential for optimization in the competitive service sector and proven effective in the tofu industry with a sigma value starting at 2.31 as a sustainability measure(Bloj et al., 2020). This advantage is due to the potential of the Stonow yellow tofu industry after COVID-19 experienced an economic downturn, with DMAIC's integrated design with statistics capable of identifying problems & the best solutions to increase efficiency & better customer satisfaction with a reduction in tofu product defects that can be reduced by 20% in the future(Costa et al., 2019; Tenera & Pinto, 2014). The Six Sigma study has contributed to the ever-changing market competition, with the effectiveness of improving process quality 10% faster than existing conditions because there is accurate identification of yellow tofu product defects from upstream, handling and downstream aspects and based on the voice of the customer(Costa et al., 2019; Pradana, Dewanti, et al., 2022; Widiwati et al., 2024).

The cause and effect diagram for yellow tofu products shows the relationship between production factors and final quality. Recipes, procedures, scheduling, instruments, calibration, data recording, skills, hygiene, nature, machines, maintenance, investment, raw materials, storage, and contamination are all interrelated and determine product quality. Solutions to address defects have been designed with a focus on employee training, cleanliness, measurements, methods, materials and machines. Implementation of this solution is expected to improve product quality and resolve consumer complaints. The design of overcoming defects is stated to require a high automation model to change worker relationships on the basis of improving worker cognition and technology in production(Baker et al., 2019; Claeys et al., 2022; Hutabarat* et al., 2020; Peruzzini et al., 2017). The skill of workers is now the difference in results, so old methods need to be adapted to increase productivity in complex manufacturing, especially in yellow tofu production in Stonow Kediri(Gleeson et al., 2019). A structured control approach with regular training, instrument setup, standardization of recipes, SOPs, data recording, and preventative maintenance is recommended to achieve quality consistency and minimize defects. This study shows that the application of Six Sigma is expected to be able to provide customer satisfaction (KPI CS) at the design & development stage, especially the Stonow Kediri yellow tofu product by identifying recurring problems & improving processes to achieve optimal results(Pereira et al., 2019). In the future, this control approach will lead to Industry 4.0 with more data that can increase production sustainability (sustainable manufacturing) through the implementation of lean six sigma which utilizes information and communication technology (ICT) for Stonow Kediri yellow tofu products(Titmarsh et al., 2020). This sustainability does not close the opportunity with a Six Sigma project policy using FANP (Fuzzy Analytical Network Process) to determine the criteria and weights for project assessment in a structured manner, so that selected projects can have maximum impact on reducing defects and customer satisfaction.(Altintas et al., 2016; Pradana et al., 2023; Pradana, Dewanti, et al., 2022; Pradana, Fahmi, et al., 2022a, 2022b).

4. Conclusion

This research increases the competitiveness of the Stonow Kediri yellow tofu industry through DMAIC with a focus on sustainable quality control. An innovative approach was used to review yellow tofu product defects by interviewing consumers directly. The increase in the average sigma level from 2.03 to 2.31 shows that the implementation of DMAIC was successful by 13.8% in improving the quality of the Stonow Kediri yellow tofu production process. This means that the number of product defects has decreased significantly, from 302,417 DPMO to 170,822 DPMO with a decrease in DPMO of 43.48%. Causative factors include recipes, procedures, scheduling, instruments, calibration, data recording, skills, hygiene, nature, machines, maintenance, investment, raw materials, storage and contamination. Stonow Kediri yellow tofu, East Java often has defects in texture, color, impurities and taste. To overcome this, it is necessary to apply Six Sigma with the DMAIC (Define, Measure, Analyze, Improve, Control) method which is accompanied by improving the production process by conducting routine training and implementing SOPs (Standard Operating Procedures) for all stages of production. Conduct regular data analysis to identify areas that need improvement. Selection of quality raw materials, namely choosing soybeans with optimal histidine, 7S β-conglycinin and B1aB1bB2B3B4 content. Added multi strain mushroom ingredients (Lactiplantibacillus plantarum and Meyerozyma guilliermondii) and Neurospora to improve taste and texture. Application of supporting technology with double ultrasonic waves to improve the taste, texture and water content of tofu. Continuous ultrasonic waves to speed up the thawing of frozen tofu. Fermentation to produce optimal taste and texture. Implementation of the HACCP program by implementing the HACCP program to prevent contamination of raw materials. Store raw materials in a dry and cool place. By implementing Six Sigma, choosing the right raw materials, supporting technology, and good storage, the quality of yellow tofu can be improved significantly. This study contributes to controlling sustainable quality and increasing the competitiveness of the Stonow Kediri yellow tofu industry. This will result in increased efficiency, quality and competitiveness, which will ultimately increase profits and consumer satisfaction.

Appendix

An appendix not.

Acknowledgments

Thank you for affiliation.

References

Adeodu, A., Maladzhi, R., Kana-Kana Katumba, M.G., & Daniyan, I. (2023). Development of an improvement framework for warehouse processes using lean six sigma (DMAIC) approach. A case of third party logistics (3PL) services. Heliyon, 9(4), e14915. https://doi.org/10.1016/j.heliyon.2023.e14915

Al Ali, RA, Yusoff, RMD, Ismail, FB, & Alhisani, AA (2019). The impact of training and employees' productivity at general directorate of residency and foreigners affairs in the UAE International Journal of Engineering and Advanced Technology, 8(6 Special Issue 3), 598–601. https://doi.org/10.35940/ijeat.F1106.0986S319

Alkhafaji, A. A., & Al Obeidy, N. Q. (2018). Improving the statistical process control chart by applying a DNOM chart for multiprocessor products. IOP Conference Series: Materials Science and Engineering, 433(1). https://doi.org/10.1088/1757-899X/433/1/012068

Altintas, M., Erginel, N., & Kucuk, G. (2016). Determining the Criteria and Evaluating Six Sigma Projects via Fuzzy ANP method in Group Decision. IFAC-PapersOnLine, 49(12), 1850–1855. https://doi.org/10.1016/j.ifacol.2016.07.852

Antosz, K., Jasiulewicz-Kaczmarek, M., Waszkowski, R., & Machado, J. (2022). Application of Lean Six Sigma for sustainable maintenance: case study. IFAC-PapersOnLine, 55(19), 181–186. https://doi.org/10.1016/j.ifacol.2022.09.204

Arifin, MHF, Mustaniroh, SA, & Sucipto, S. (2021). Application of the six sigma DMAIC in quality control of potato chips to reduce production defects. IOP Conference Series: Earth and Environmental Science, 924(1), 012056. https://doi.org/10.1088/1755-1315/924/1/012056

Baker, R., Coenen, P., Howie, E., Williamson, A., & Straker, L. (2019). The musculoskeletal and cognitive effects of under-desk cycling compared to sitting for office workers. Applied Ergonomics, 79(May), 76–85. https://doi.org/10.1016/j.apergo.2019.04.011

Berti, N., Serena, F., Mattia, G., Monica, R., & Daria, B. (2022). Real-time postural training effects on single and multi-person ergonomic risk scores. IFAC-PapersOnLine, 55(10), 163–168. https://doi.org/10.1016/j.ifacol.2022.09.384

Blinnikova, OM, Babushkin, VA, Akindinov, VV, Perfilova, OV, & Novikova, IM (2020). Production technology and mathematical method for modeling the formulation of fruit and jelly candies enriched with collagen. IOP Conference Series: Materials Science and Engineering, 919(5). https://doi.org/10.1088/1757-899X/919/5/052036

Bloj, M.D., Moica, S., & Veres, C. (2020). Lean six sigma in the energy service sector: A case study. Procedia Manufacturing, 46(2019), 352–358. https://doi.org/10.1016/j.promfg.2020.03.051

CHEN, B. yu, LI, Q. zhai, HU, H., Meng, S., SHAH, F., WANG, Q., & LIU, H. zhi. (2020). An optimized industry processing technology of peanut tofu and the novel prediction model for suitable peanut varieties. Journal of Integrative Agriculture, 19(9), 2340–2351. https://doi.org/10.1016/S2095-3119(20)63249-X

Chen, J., Cai, L., Huang, X., Fu, H., Sun, L., Yuan, C., Gong, H., Lyu, B., Wang, Z., & Yu, H. (2024). Mathematical modeling of optimal coagulant dosage for tofu preparation using MgCl2. Food Chemistry:

Claeys, A., Hoedt, S., Domken, C., Aghezzaf, E. H., Claeys, D., & Cottyn, J. (2022). Methodology to integrate ergonomics information in contextualized digital work instructions. Procedia

CIRP, 106(March), 168–173. https://doi.org/10.1016/j.procir.2022.02.173

Costa, J.P., Lopes, I.S., & Brito, J.P. (2019). Six Sigma application for quality improvement of the pin insertion process. Procedia Manufacturing, 38(2019), 1592–1599. https://doi.org/10.1016/j.promfg.2020.01.126

Dai, Y., Xu, Z., Wang, Z., Li, X., Dong, J., & Xia, X. (2023). Effects of fermentation temperature on bacterial community, physicochemical properties and volatile flavor in fermented soy whey and its coagulated tofu. Lwt, 173(November 2022), 114355. https://doi.org/10.1016/j.lwt.2022.114355

Daniyan, I., Adeodu, A., Mpofu, K., Maladzhi, R., & Kana-Kana Katumba, M.G. (2022). Application of lean Six Sigma methodology using DMAIC approach for the improvement of bogie assembly process in the railcar industry. Heliyon, 8(3), e09043. https://doi.org/10.1016/j.heliyon.2022.e09043

De Menna, F., Dietershagen, J., Loubiere, M., & Vittuari, M. (2018). Life cycle costing of food waste: A review of methodological approaches. Waste Management, 73, 1–13. https://doi.org/10.1016/j.wasman.2017.12.032

Dewanti, RP, Paryanto, E., Pradana, JA, & Harsito, C. (2022). Financial Feasibility of Modification Workshop Case Studies: Be-Modified. International Journal of Sustainable Development and Planning, 17(6), 1865–1871. https://doi.org/10.18280/ijsdp.170621

Ertürk, M., Tuerdi(Maimaitiaili. Tuerdi), M., & Wujiabudula, A. (2016). The Effects of Six Sigma Approach on Business Performance: A Study of White Goods (Home Appliances) Sector in Turkey. Procedia - Social and Behavioral Sciences, 229, 444–452. https://doi.org/10.1016/j.sbspro.2016.07.154

Fentis, A., Rafik, M., Bahatti, L., Bouattane, O., & Mestari, M. (2022). Data driven approach to forecast the next day aggregate production of scattered small rooftop solar photovoltaic systems without meteorological parameters. Energy Reports, 8, 3221–3233. https://doi.org/10.1016/j.egyr.2022.02.088

Gagnon, R.D., Langevin, M. È., Lutin, F., & Bazinet, L. (2023). Impact of nanofiltration pre-concentration prior to a combination of electrodialytic processes on the extraction of proteins from tofu whey. Future Foods, 8(September). https://doi.org/10.1016/j.fufo.2023.100258

Gleeson, F., Coughlan, P., Goodman, L., Newell, A., & Hargaden, V. (2019). Improving manufacturing productivity by combining cognitive engineering and lean-six sigma methods. Procedia CIRP, 81(March), 641–646. https://doi.org/10.1016/j.procir.2019.03.169

Guan, T., Fu, S., Wu, X., Yu, H., & Liu, Y. (2024). Bioturbation effect of artificial inoculation on the flavor metabolites and bacterial communities in the Chinese Mao-tofu fermentation. Food Chemistry:

Hariyani, D., & Mishra, S. (2022). Drivers for the adoption of integrated sustainable green lean six sigma agile manufacturing system (ISGLSAMS) and research directions. Cleaner Engineering and Technology, 7, 100449. https://doi.org/10.1016/j.clet.2022.100449

Hariyani, D., & Mishra, S. (2023). Structural Equation Modeling of Drivers for the Adoption of an Integrated Sustainable-Green-Lean-Six Sigma-Agile Manufacturing System (ISGLSAMS) in Indian Manufacturing Organizations. Cleaner and Circular Bioeconomy, 4(December 2022), 100037. https://doi.org/10.1016/j.clcb.2023.100037

Hariyani, D., Mishra, S., Sharma, M. K., & Hariyani, P. (2023). A study of the barriers to the adoption of integrated sustainable-green-lean-six sigma-agile manufacturing system

(ISGLSAMS) in Indian manufacturing organizations. Cleaner Waste Systems, 5(May), 100098. https://doi.org/10.1016/j.clwas.2023.100098

Hutabarat*, J., Suardika, IB, Basuki, DWL, Septiari, R., & Ramadhani, A. (2020). Stretching Interventions and Their Effect on Mental Workload. International Journal of Innovative Technology and Exploring Engineering, 9(7), 286–295. https://doi.org/10.35940/ijitee.g4982.059720

Indrasari, LD, Komari, A., Tripariyanto, AY, Sanjaya, KT, & Lutfianto, S. (2021). DMAIC Methodology to Minimize Rejection of Yellow Tofu Products by Distributor Agents. Journal of Research and Technology, 7(2), 123–137.

Komari, A., Indrasari, LD, & Salsabillah, VK (2022). Financial Feasibility Analysis for Increasing the Production Capacity of Yellow Tofu MSMEs. Journal of Research and Technology, 8(1), 149-159.

Lei, W., Zhu, Y., Zhu, X., Huang, Y., Liu, L., Lü, M., & Sun, B. (2023). Effect of ultrasound treatment on thawing process of frozen tofu prepared with different salt coagulants. Ultrasonics Sonochemistry, 99(September), 106578. https://doi.org/10.1016/j.ultsonch.2023.106578

Lu, W., Zhang, Y., Ye, Q., Chen, D., Zhang, C., & Xiao, C. (2022). Evaluation of the quality of whole bean tofu prepared from high-speed homogenized soy flour. Lwt, 172(November), 114214. https://doi.org/10.1016/j.lwt.2022.114214

Mittal, A., Gupta, P., Kumar, V., Al Owad, A., Mahlawat, S., & Singh, S. (2023). The performance improvement analysis using Six Sigma DMAIC methodology: A case study on Indian manufacturing company. Heliyon, 9(3), e14625. https://doi.org/10.1016/j.heliyon.2023.e14625

Mohamed, M. K. E., Montague, G., Glassey, J., Morrow, P., Ryan, V., & Dawson, S. (2024). Industrial implementation of an inline near infrared process control system for the production of caramel. Journal of Food Engineering, 361, 111717. https://doi.org/https://doi.org/10.1016/j.jfoodeng.2023.111717

Pereira, M.T., Inês Bento, M., Ferreira, L.P., Sá, J.C., & Silva, F.J.G. (2019). Using Six Sigma to analyze Customer Satisfaction at the product design and development stage. Procedia Manufacturing, 38(2019), 1608–1614. https://doi.org/10.1016/j.promfg.2020.01.124

Peruzzini, M., Carassai, S., & Pellicciari, M. (2017). The Benefits of Human-centred Design in Industrial Practices: Re-design of Workstations in Pipe Industry. Procedia Manufacturing, 11(June), 1247–1254. https://doi.org/10.1016/j.promfg.2017.07.251

Pradana, JA, Dewanti, RP, Harsito, C., Rowi, S., & Salsabila, VK (2022). Integration of Fuzzy Mamdani Biomechanics and Niosh: Material Handling Manual for Soybean Slurry Filtering. KAIZEN : Management Systems & Industrial Engineering Journal, 05(01), 8–14.

Pradana, JA, Fahmi, IF, Indiarto, EPS, & Haristanti, SNM (2022a). Fuzzy Sugeno- Biomechanics- NIOSH- NBM: Risk Assessment of Soybean Slurry Filtering Activities. Taguchi Journal: Scientific Journal of Industrial Engineering and Management, 2(1), 26–36.

Pradana, JA, Fahmi, IF, Indiarto, EPS, & Haristanti, SNM (2022b). Fuzzy Sugeno- Biomechanics- NIOSH-NBM: Risk Assessment of Soybean Slurry Filtering Activities. Taguchi Journal: Scientific Journal of Industrial Engineering and Management, 2(01), 1–9.

Pradana, JA, Hariastuti, NLP, & Lukmandono, L. (2023). ADMINISTRATIVE SERVICE PRIORITY USING THE FUZZY-SERVQUAL-IPA METHOD. KAIZEN : Management Systems & Industrial Engineering Journal, 6(1), 34–42.

Pugna, A., Negrea, R., & Miclea, S. (2016). Using Six Sigma Methodology to Improve the Assembly Process in an Automotive Company. Procedia - Social and Behavioral Sciences, 221, 308–316. https://doi.org/10.1016/j.sbspro.2016.05.120

Qiu, Y., Ye, S., Huang, X., Li, C., Feng, Y., Xia, M., Yu, Q., Zhang, X., & Wang, Q. (2023). Fermentation with a multi-strain to enhance the flavor of HongJun Tofu, a Chinese fermented okara food. Lwt, 189(November), 115495. https://doi.org/10.1016/j.lwt.2023.115495

Shannon, N., Trubetskaya, A., Iqbal, J., & McDermott, O. (2023). A total productive maintenance & reliability framework for an active pharmaceutical ingredient plant utilization design for Lean Six Sigma. Heliyon, 9(10), e20516. https://doi.org/10.1016/j.heliyon.2023.e20516

Sucipto, Susilowati, E., & Effendi, U. (2020). Reducing waste on wheat flour packaging: An analysis of Lean Six Sigma. IOP Conference Series: Earth and Environmental Science, 475(1). https://doi.org/10.1088/1755-1315/475/1/012002

Sulistiyowati, W., Adamy, MR, & Jakaria, RB (2019). Product quality control based on lean manufacturing and root cause analysis methods. Journal of Physics: Conference Series, 1402(2). https://doi.org/10.1088/1742-6596/1402/2/022038

Tenera, A., & Pinto, L. C. (2014). A Lean Six Sigma (LSS) Project Management Improvement Model. Procedia - Social and Behavioral Sciences, 119, 912–920. https://doi.org/10.1016/j.sbspro.2014.03.102

Tindjau, R., Chua, J.Y., & Liu, S.Q. (2023). Growth and metabolic behavior of probiotic Bifidobacteria longum subsp. longum in minimally supplemented soy (tofu) whey. Future Foods, 8(September), 100272. https://doi.org/10.1016/j.fufo.2023.100272

Titmarsh, R., Assad, F., & Harrison, R. (2020). Contributions of lean six sigma to sustainable manufacturing requirements: An industry 4.0 perspective. Procedia CIRP, 90(March), 589–593. https://doi.org/10.1016/j.procir.2020.02.044

Utama, DM, & Abirfatin, M. (2023). Sustainable Lean Six-sigma: A new framework for improving sustainable manufacturing performance. Cleaner Engineering and Technology, 17(October), 100700. https://doi.org/10.1016/j.clet.2023.100700

Vicente, I., Godina, R., & Teresa Gabriel, A. (2024). Applications and future perspectives of integrating Lean Six Sigma and Ergonomics. Safety Science, 172(January). https://doi.org/10.1016/j.ssci.2024.106418

Vincent, A., Pocius, D., & Huang, Y. (2021). Six Sigma performance of quality indicators in total testing process of point-of-care glucose measurement: A two-year review. Practical Laboratory Medicine, 25, e00215. https://doi.org/10.1016/j.plabm.2021.e00215

Widiwati, ITB, Liman, SD, & Nurprihatin, F. (2024). The implementation of Lean Six Sigma approach to minimize waste in a food manufacturing industry. Journal of Engineering Research, January. https://doi.org/10.1016/j.jer.2024.01.022

Zhang, L., Wang, X., Qu, W., Zhang, A., Wahia, H., Gao, X., Ma, H., & Zhou, C. (2022). Evaluation of dual-frequency multi-angle ultrasound on physicochemical properties of tofu gel and its finished product by TOPSIS-entropy weight method. Ultrasonics Sonochemistry, 90(August), 106196. https://doi.org/10.1016/j.ultsonch.2022.106196