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Increasing Selling Value of Processed Shrimp Products Using Strategies Developed by Six Sigma and Human Factor Integration

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Abstract. *The export value of the Indonesian fisheries sector, including the shrimp industry, increases every year. Effective and efficient production processes are needed to maintain product quality, ensuring business sustainability. This study aims to determine the potential causes of shrimp product failure and provide improvement recommendations. The case study is one of the shrimp export industries in East Java, with the stretching process of shrimp sizes of 26-30, 2LX, L OIE, and 2L OIE. The results showed that size 26-30 had the most considerable defect per million opportunities (DPMO), with a value of 574,948 and a sigma value of 1.31. The cause of product defects with the highest risk priority number (RPN) is low labor motivation. The calculations using Herzberg's Theory show that the wage issue has the lowest value of 3.38. A SWOT analysis was then conducted to design a business strategy. The result shows that the company's position was in Quadrant 3, meaning it needs to change its strategy. The focus group discussions (FGDs) resulted in four recommendations, with a change in the wage scheme receiving the highest alternative weight evaluation value of 0.385.*

Keywords: *DMAIC, FMEA, Herzberg Theory, SWOT Analysis, AHP, Shrimps.*

I. INTRODUCTION

The Indonesian fisheries sector has shown steady growth over the years, which can be seen from the increase in the annual trade balance by 6.32% from 2017 to 2021 (Ministry of Marine Affairs and Fisheries, 2022). This growth is expected to continue, so follow-ups are needed to maintain the success and sustainability of the business process system. This is especially important for the country’s ten main export products, including shrimp products (Ministry of Marine Affairs and Fisheries, 2022), whose production has increased by 8.63% (Ministry of Marine Affairs and Fisheries, 2022).

The complex production cycle of export products, including shrimps, and the economy's complexity, such as product diversification capability, reflect a country’s economic performance (Shahzad, Madaleno, Dagar, & Ghosh, 2022). In Indonesia, the export industry’s performance is increasing due to the global demand for the commodity sector (Sukmaya & Saptana, 2021). Therefore, optimizing the production cycle to improve and maintain product quality is necessary.

On a company level, sales diversification positively impacts the production process optimization with technology (Song, Wu, Deng, & Deng, 2020) and the existing resources in all processes. Evaluating production efficiency and resource optimization can produce superior products (Mwaurah et al., 2019). Efficiency is achieved when the production connects all resources to achieve output that meets the provisions. Such efficiency is crucial because the export industry's production system impacts other economic sectors. Besides, government policies often prioritize exports through economic cooperation and accelerated promotions (Azahari et al., 2021), which often increases the quality of both domestic and international shipments. Maintaining product quality to ensure buyers’ trust can be done by following the standards. A process that does not support the goal of meeting the product standards will lead to a defect (Pratama, Imtihan, & Nugroho, 2020).

This study focuses on the shrimp export industry in East Java, with a case study of a company producing conventional shrimp

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products. In the production process, defects were found in each batch; for size 2LX by 16%, size 26-30 by 29%, size L OIE by 15%, and size 2L OIE by 14%. Examining the cause of the problem is important to provide recommendations for future improvements and adjust to existing quality standards. This study uses Six Sigma through the Define, Measure, Analyze, Improve, Control (DMAIC) method, aiming to reduce defects to eliminate waste and minimize the company's losses (Siregar, 2019). The Six Sigma approach determines the value of a process capability index, which estimates the significance of an improvement strategy. It can reduce defects in the production process (Kurnia, Jaqin, Purba, & Setiawan, 2021), optimize processes (Francisco Silva et al., 2022) and output results, contribute to economic benefits (Guo, Jiang, Xu, & Peng, 2019), and improve product offering processes (Wartati, Garza-Reyes, Dieste, Nadeem, & González-aleu, 2021).

Six Sigma, through the DMAIC method, has been used in various settings in past research. For example, Krishna Priya, Jayakumar, and Suresh Kumar (2020) use Six Sigma for automotive assembly stations to reduce or eliminate non-value-added processes in the production chain. Ponsiglione et al. (2021) use DMAIC as the Health Technology Assessment (HTA) to evaluate health services, manage health center processes more efficiently, and integrate medical technology. Kurnia, Jaqin, and Manurung (2022) discuss the increasing Sigma values and use of Six Sigma in a textile industry that produces elastic bands. C.R. and Thakkar (2019) use Six Sigma through the DMAIC method to reduce product defects in the cabinet door production process. Daniyan, Adeodu, Mpofu, Maladzhi, and Kana-Kana Katumba (2022) discuss the application of Six Sigma to improve the assembly process of a train carriage.

The novelty in this study is the design of a strategy integrating complex resources and improving soft resources. Complex resource system repairs are completed using the Six Sigma method, while soft resource system improvements are completed using the human factor concept approach.

II. Research Method

Survey. A survey was conducted with one of the technical managers in the shrimp industry to identify the production process in the processing of semi-finished shrimp products. This research focuses on the processed Nobashi shrimp because it is a superior commodity produced in the East Java export industry. A follow-up survey was also conducted to determine the severity level, occurrence, and detection of product defects. Next, a causal analysis is carried out to discover more about the product defects by interviewing operators, e.g., the production process, specifications, and defective products.

Six Sigma. The Six Sigma method aims to improve and control quality in the quality management of a process. According to Gasperz (2005), six aspects to pay attention to are (1) identification of product characteristics for customer satisfaction, (2) classification of product quality characteristics, (3) control through resources (materials, machines, work processes, and so on), (4) determining the maximum tolerance limit for each critical to quality (CTQ), (5) determining the maximum process variation for each CTQ, (6) Suggesting changes to achieve the Six Sigma target value. The purpose of Six Sigma is to increase the performance of a system on specific processes. Meanwhile, CTQ is used in tools for data analysis to determine customer needs (Tjahjono et al., 2010).

DMAIC. Define, Measure, Analyze, Improve, Control (DMAIC) is an approach that can solve extensive problems by defining and diagnosing problems and designing improvement strategies (De Mast & Lokkerbol, 2012). The five stages of solving problems using this method are stated in the name: define, measure, analyze, improve, and control. The details are as follows (Erdoğan & Canatan, 2015):

1. Define. This initial step determines a product or process's critical to quality (CTQ) or measurable quality characteristics.
2. Measure. This step calculates the process conditions by evaluating the Defect per Million Opportunities (DPMO) value and the sigma value.

3. Analyze. This stage identifies the causes and the sources of defects in products and processes. The aim is to contribute to and update the production system for sustainability and future improvements.
4. Improve. At this stage, plans and actions are carried out to improve quality and rectify existing problems.
5. Control. This stage monitors the factors that can be a source of problems. This aims to maintain the stability of the systems or processes that have been updated.

FMEA. Failure Modes and Effects Analysis (FMEA) is used to identify critical risk activities and predict system failures to avoid other potential failures and their impact on operations (Chang, Chang, & Lai, 2014). FMEA works by prioritizing the causes of failure to support the development of a new process or activity, unlike other approaches that focus on analyzing adverse events after they occur (H. C. Liu, You, Li, & Su, 2016). The calculation used is as follows:

RPN = Severity *Occurrence *Detection

The rating is as follows (Mayangsari, Adianto, & Yuniati, 2015):

a. Severity: Calculating the impact magnitude of events that affect the final results of the process
b. Occurrence: The possibility of failure will occur until the end of the process is carried out
c. Detection: Estimating the control value of the cause of the defect from the internal organization before the general public discovers it.

Human Factors. The human factor is recognized as an essential part of lean manufacturing (Bouranta, Psomas, & Antony, 2022). Most companies adopting lean manufacturing fail to achieve sustainable results despite gaining initial operational performance. This is caused by the workforce (human factor), which is not fully involved in the long-term implementation of the program (Costa et al., 2019). In other words, in the long term, a company's operational performance is influenced by the behavior of the workforce, supported by the physical work environment and job characteristics, mediated by the individual characteristics of the workforce (Gaiardelli, Resta, & Dotti, 2019).

In addition, the human factor and the motivation and involvement of senior management at all levels are fundamental to achieving the company's best operational performance (Hernandez-Matias, Ocampo, Hidalgo, & Vizan, 2020). Herzberg's two-factor theory has been used to explore the impact of job satisfaction on employee motivation (Alrawahi, Sellgren, Altouby, Alwahaibi, & Brommels, 2020). Herzberg's two-factor theory is used in developing the capability of an existing process. Some factors to consider are hygiene and motivational factors (Andriani et al., 2017).

SWOT analysis. Strengths, weaknesses, opportunities, and threats (SWOT) analysis is a tool that has been researched for more than six decades and is used by business people for strategic planning (Benzaghta, Elwalda, Mousa, Erkan, & Rahman, 2021). SWOT analysis works by analyzing a company from an internal and external perspective to produce strategies for the company (Quezada. Luis E, Reinao. Eduardo A., Palominos. Pedro I, & Oddershede. Astrid M, 2019) and determine decisions by positioning organizational resources and environment in four categories: strengths, weaknesses, opportunities, and threats (Phadermrod, Crowder, & Wills, 2019). The external and internal factors that form the basis of a SWOT analysis must be specific to formulate an appropriate strategy (David, Creek, & David, 2019).

Analytical Hierarchy Process (AHP). Decision-making theory is multidisciplinary and uses different methods to make quality decisions. One recommended method is the analytical hierarchy process (AHP) (Canco, Kruja, & Iancu, 2021). The AHP method sets values to help classify and select alternatives based on a hierarchical structure (Leal, 2020). The AHP's advantages are that it is easy to use, solves problems systematically, and calculates the weight of the criteria and priority alternatives (Y. Liu, Eckert, & Earl, 2020). In the case of multi-criteria decision-making, AHP is preferred and applied in various fields, such as environmental science, management science, manufacturing engineering, energy evaluation, and selection (Yu, Kou, Xu, & Shi, 2021

III. RESULT AND DISCUSSION

The Six Sigma method can be used to perform quality control tests. By carrying out these tests, a company can determine the level of ability or performance in the quality control to improve its production process. As such, product quality can be maintained, and product defects can be reduced. The results of research data analysis using the Six Sigma method with DMAIC stages are as follows:

Table 1. Shrimp Size Specification

No	Type	Size
1	26-30	The maximum length is 14 cm, and a minimum of 13.5 cm
2	2LX	The maximum length is 14.5 cm, and the minimum is 14 cm
3	L OIE	The maximum length is 13.5 cm, and the minimum is 13 cm.
4	2L OIE	The maximum length is 14.5 cm, and the minimum is 14 cm.

Table 2. Product Specifications

Type Specifications: Shrimp Size Length		Sizes 26-30	Size 2L OIE	Size L OIE	Size 2LX
Upper Specification Limit	USL	14	14.5	13.5	14.5
Lower Specification Limit	MSM	13.5	14	13.0	14
Target Specification Value	Q	13,8	14,3	13,3	14,3

Table 3. Calculation of DPMO Value

Calculation	Equality	Size 26-30	Size 2L OIE	Size L OIE	Size 2LX
Process Means	X-Bar	13.51	14,23	13,23	14,10
Standard Deviation Value	S	0.36	0.32	0.32	0.33
Chances of Defects that are above USL per million opportunities	P [z ≥ (USL - X-bar) / S] x 1,000,000	86,915	200,000	200,000	113,14
Probability of Disability being below MSM per one million opportunities	P [z ≤ (LSL - X-bar) / S] x 1,000,000	488,033	235,672	235,672	382,089
Probability of defects per million opportunities (DPMO)	USL DPMO + MSM DPMO	574,948	435,672	435,672	495,229

Define

This stage defines defective products based on the shrimp products' sizes, as shown in Table 1. The findings show that the defects are the vein (the flesh' pale color), the blackspot (black spots or patterns on the flesh), the molting (the coating's hard texture), the broken tail (the tail defects), the scar (wounds on the flesh), over length (the length exceeding the specification), under length (the length of is less than the specification).

Measures

The value is calculated from the DPMO value of each type of shrimp. The product specifications for the calculation are listed in Table 2. The product specification is then followed by the calculation of the DPMO value as in Table 3.

The calculation of the sigma value is based on the DPMO value of the Nobashi shrimp products. The stretching process aims to obtain the sizes with the most and least defective products, resulting in sizes 26-20 (1.31), 2L OIE (1.66), L OIE (1.66), and 2LX (1.51). The smallest sigma value of the four sizes from the stretching process is size 26-30, with a sigma value of 1.31, followed by size 2LX, with a sigma value of 1.51. The sizes with the highest sigma value are 2L OIE and LOIE sizes with a sigma value of 1.66. The sigma value of the four sizes can be considered low, below the industry average in Indonesia, at 3 to 4.

Analyze

The analysis stage is the third stage of the DMAIC stages, i.e., examining the Pareto diagram to determine the size with the most dominant defect and the fishbone diagrams to describe the factors that cause defects. Figures 1 and 2 show the Pareto and fishbone diagrams, respectively.

The results of the Pareto diagram show that shrimps sized 26-30 has a defect percentage of

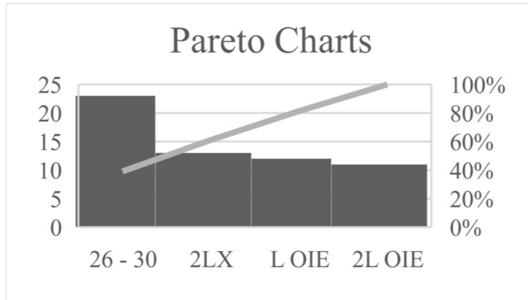

Figure 1. Pareto Calculation of the Product Defects

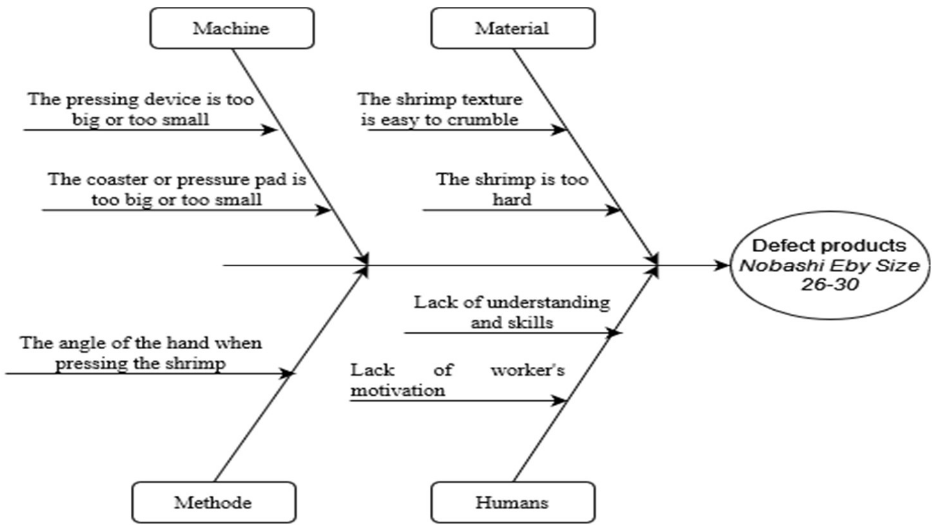

Figure 2. Diagram of Cause and Effect of Shrimp Product Defects

38.98%. This is followed by the 2LX size, with a percentage of 22.03%; the L OIE size, with a percentage of 20.34%; and the 2L OIE size, with a percentage of 18.64%. A further analysis using a fishbone diagram to analyze the causes and effects of the product defect is as Figure 2.

The causes of the problem may come from the machine, such as the sizes of the pressing tool, the coaster, or the pressure pad that is not suitable. They can cause damage or a sub-optimal pressing process. The material factor is because the shrimp's flesh is easily crumbled, which leads to brittle and damaged products when the shrimp is pressed. Likewise, the pressing process cannot be stretched optimally if the shrimp is too hard. The angle of the hand when pressing the shrimp can also cause defects. The angle distributes compressive force to the shrimp's part. When it is not evenly distributed, the stretching process is not optimal. Likewise, human factors, such as the lack of understanding, skills, and motivation, can lead to defects. Labor performance is also a defect predictor because the stretching process is carried out manually. Low labor performance leads to non-optimal results as well.

Improve

The improvement recommendations are formulated from the FMEA calculation, i.e., the risk priority number (RPN) values, which indicate the sources of the problem to be addressed immediately. The RPN value is multiplied by severity, occurrence, and detection. Table 4 presents the FMEA calculation results.

The analysis of the causes or sources of the problem is based on the highest RPN value and the company's recommendation. As shown in Table 4, the highest and recommended RPN value is the workers' lack of motivation, with an RPN value of 168. The recommended improvement using Herzberg's two-factor theory by measuring workers' motivation in the stretching process

Table 4. The RPN Calculation Recapitulation

Problem	Potential Failure	Severity	Occurrence	Detectability	RPN	Action
Shrimp Product Defects	The pressing device is too big or too small	9	6	8	432	done
	The coaster or pressure pad is too big or too small	6	6	8	288	done
	The shrimp texture is easy to crumble	9	6	3	162	Recommended
	The shrimp is too hard	5	5	3	75	Recommended
	The angle of the hand when pressing the shrimp	8	7	9	504	done
	Lack of understanding and skills	8	7	6	336	done
	Lack of labor's motivation	6	4	7	168	Recommended

reveals the need to recognize (1) the workers' intrinsic needs, i.e., achievement, recognition, the work itself, responsibility, opportunities for advancement, and (2) the workers' extrinsic needs, i.e., wage, regulation, promotion, supervision, interpersonal relationships, working conditions, and job security. Table 5 shows the calculation results of Herzberg's Two-Factor Theory.

Table 5. Calculation Results of Herzberg's Two-Factor Theory

Indicator	Means	Meaning
Intrinsic		
Performance	3.63	Enough
Confession	3.79	Enough
The job itself	3.77	Enough
Responsibility	3.65	Enough
Opportunity to advance	3,47	Enough
Extrinsic		
Wage	3.38	Enough
Regulation	3,44	Enough
Supervision	4.02	Good
Interpersonal Relations	4,25	Good
Working Conditions	3.63	Enough
Job Security	4.46	Good

Workers' motivation in the shrimp export industry in East Java, particularly in the stretching process, seems sufficient, with an average score for all work motivation indicator statements of 3.75. However, companies can review the wage scheme to increase motivation to improve the production process. This is because the lowest score in the calculation of Herzberg's two-factor theory is the wages, with a value of 3.38.

Next, a SWOT analysis was carried out to design the business strategy. The analysis examines the company's internal and external factors to inform the business strategy formulation. Table 6 shows the results of the SWOT analysis.

Table 6. The SWOT Analysis

Code	Strength _ _
A	Good interpersonal relations in the working environment
B	Comfortable working conditions
C	Guaranteed job security
	Weaknesses _ _
D	Low wages
E	Strict company regulations
F	Strict supervision
Code	Opportunity _ _
A	Limited job opportunities make the workforce choose to compromise
B	Establishing cooperation with trade unions to exercise the right to organize and unite
C	Work experience for workers
	Threats _ _
D	Other industries in the sector offer higher salaries
E	Other industries in the sector offer more facilities
F	Increasing the regional minimum wage every year

Through the SWOT analysis, several factors were found in the form of strengths, weaknesses, opportunities, and threats, each weighted and rated to estimate the company's position. Table 7 shows the result of weighting and rating.

The rating results of the SWOT calculation show that the total value of strength and weakness is -0.13333. Meanwhile, the total value of opportunity and threat is -0.26667. A SWOT diagram is prepared from the SWOT calculations, as shown in Figure 3.

The SWOT diagram shows that the company's current position is in Quadrant 3, which means that the company has opportunities, but it also faces obstacles, i.e., internal weaknesses. The appropriate strategy for this quadrant is to shift the existing strategies to

Table 7. The SWOT Weighting and Rating Results

Code	Weight	Rating	Score
A	0.2	3	0.6
B	0.066667	3	0.2
C	0.066667	4	0.266667
	Total		**1.066667**
D	0.333333	2	0.666667
E	0.2	2	0.4
F	0.133333	1	0.133333
	Total		**1,2**
	Total SW		-0.13333
Initials	**Weight**	**Rating**	**Score**
A	0.133333	4	0.533333
B	0.066667	1	0.066667
C	0.133333	2	0.266667
	Total		**0.866667**
D	0.266667	1	0.266667
E	0.333333	2	0.666667
F	0.066667	3	0.2
	Total		**1.133333**
	Total OT		-0.26667

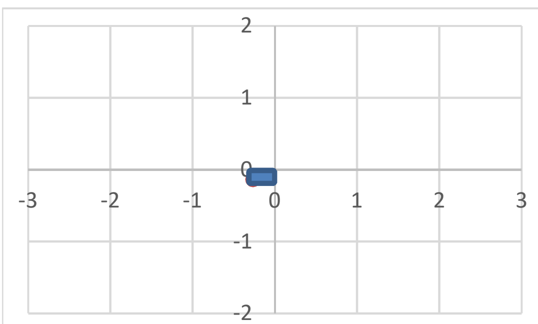

Figure 3. The SWOT Diagram

internal condition improvement. This way, they can optimize their performance and take advantage of existing opportunities.

Herzberg's theory of motivation indicates that companies need to examine the workers' waging scheme further. The results of SWOT also indicate that the company needs to change its labor-related business strategies. Based on these results, the recommendations for improving the existing problems must focus on the workforce. The FGDs conducted with the workforce result in four recommendations for improvement, as shown in Table 8.

The proposed recommendations are further analyzed to produce an improvement strategy. The recommendations are selected using the analytical hierarchy process (AHP) method, which means that they are analyzed first with the pre-determined criteria shown in Table 9.

Table 8. Suggestions for Improvements

	Alternative	
A	Changes in the wage model	Changes in the wage model from what was originally based on the number of hours worked to the number of products
B	Providing pensions	Provision of retirement funds for workers with a certain duration of service
C	Establishment of a bonus system	A bonus system for certain achievements can be established based on the production volume (exceeding the target), minimal defective products, shorter production times, etc.
D	Adjustment of overtime fees	Review of overtime funds

Table 9. The AHP Criteria

Criteria
Easily accepted by the workforce
Easy to implement
Easy to control

Alternative decision-making is based on the calculation of the weight comparison of the alternatives against the criteria. The results of the calculation of the alternative decisions are listed in Table 10.

Based on the calculation results, the alternative with the highest weight evaluation value is changing the wage model, with a value of 0.385; followed by an alternative to providing pensions with a value of 0.277, adjustment of overtime funds with a value of 0.172, and design of a bonus system with a value of 0.166.

IV. Conclusion

This research collects data on the stretching process of Nobashi shrimp products, consisting of 59 products from four sizes, namely 2LX, 26-30, L OIE, and 2L OIE. Based on the calculation results of the Defect per Million Opportunities (DPMO) value and the sigma size value, size 26-30 has the highest DPMO value of 574,948 and the lowest sigma value of 1.31. This is followed by the size 2LX with a DPMO value of 495,229 and a sigma

Table 10. Alternative Calculation Results

	Attribute			Alternative Weight Evaluation
	Easily accepted by the workforce	Easy to implement	Easy to control	
Attribute weight	0.3042	0.1721	0.5237	
Alternative				
Changes in the wage model	0.2544	0.2038	0.5205	0.385
Providing pensions	0.3361	0.3035	0.2333	0.277
Bonus system design	0.2708	0.1962	0.0949	0.166
Adjustment of overtime funds	0.1386	0.2966	0.1513	0.172

value of 1.51. Meanwhile, sizes 2L OIE and L OIE have the lowest DPMO value and the highest sigma value, at 435,672 and 1.66, respectively. Based on the observations, the causes or sources of problems that lead to defects are identified. The results show that the problems include the size of the pressing device being too small or too large, the size of the coaster or pressure pad mat being too large or small, the texture of the shrimp being easily crumbled, the shrimp being too hard, the angle hands when pressing, the lack of understanding and skill of the workforce, and lack of workers' motivation. The two-factor theory analysis shows that labor wages have the lowest score at 3.38. Next, a SWOT analysis was conducted to design a business strategy. The finding shows that the company's position is in Quadrant 3, indicating the need to change the strategy.

Furthermore, FGDs were conducted to obtain recommendations for improvement. The four recommendations are (1) changing the wage model, (2) providing pensions, (3) designing a bonus system, and (4) adjusting overtime fees. Based on the results of AHP calculations, changing the wage model is a recommendation with the highest alternative weight evaluation value, at 0.385.

References

Alrawahi, S., Sellgren, SF, Altouby, S., Alwahaibi, N., & Brommels, M. (2020). Applying Herzberg's two-factor theory of motivation to job satisfaction in clinical laboratories in Omani hospitals. Heliyon, 6 (9), e04829. https://doi.org/10.1016/j.heliyon.2020.e04829

Andriani, M., Widiawati, K., Administration, M., Secretary, A., Management, D., Insani, B., ... East, B. (2017). 2 Secretaries; Academy of Secretary and Human Development Management; Jl. Siliwangi No. 6 Rawa Panjang East Bekasi 17114 Indonesia. 5 (1), 83–98.

Azahari, DH, Purba, HJ, Dervish, V., Dabukke, F., Hestina, J., & Yusuf, ES (2021). The competitiveness of Indonesia's pepper exports and its challenges. IOP Conf. Series: Earth and Environmental Science, 892 (No 1), P. 012074. https://doi.org/10.1088/1755-1315/892/1/012074

Benzaghta, MA, Elwalda, A., Mousa, M., Erkan, I., & Rahman, M. (2021). SWOT analysis applications: An integrative literature review. Journal of Global Business Insights, 6 (1), 55–73. https://doi.org/10.5038/2640-6489.6.1.1148

Bouranta, N., Psomas, E., & Antony, J. (2022). Human factors involved in lean management: a systematic literature review. Total Quality Management and Business Excellence, 33 (9–10), 1113–1145. https://doi.org/10.1080/14783363.2021.1936481

Canco, I., Kruja, D., & Iancu, T. (2021). Ahp, a reliable method for quality decision making: A case study in business. Sustainability (Switzerland), 13 (24). https://doi.org/10.3390/su132413932

Chang, KH, Chang, YC, & Lai, PT (2014). Applying the concept of exponential approach to enhance the assessment capability of FMEA. Journal of Intelligent Manufacturing, 25 (6), 1413–1427. https://doi.org/10.1007/s10845-013-0747-9

Costa, F., Lispi, L., Staudacher, AP, Rossini, M., Kundu, K., & Cifone, FD (2019). How to foster Sustainable Continuous Improvement: A cause-effect relations map of Lean soft practices. Operations Research Perspectives, 6 (December 2018), 100091. https://doi.org/10.1016/j.orp.2018.100091

CR, A., & Thakkar, JJ (2019). Application of Six Sigma DMAIC methodology to reduce the defects in a telecommunication cabinet door manufacturing process: A case study. International Journal of Quality and Reliability Management, 36 (9), 1540–1555. https://doi.org/10.1108/IJQRM-12-2018-0344

Daniyan, I., Adeodu, A., Mpofu, K., Maladzhi, R., & Kana-Kana Katumba, MG (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

David, FR, Creek, SA, & David, FR (2019). What is the Key to Effective SWOT Analysis, Including AQCD Factors. In SAM Advanced Management Journal (Vol. 84).

De Mast, J., & Lokkerbol, J. (2012). An analysis of the Six Sigma DMAIC method from the perspective of problem solving. International Journal of Production Economics, 139 (2), 604–614. https://doi.org/10.1016/j.ijpe.2012.05.035

Erdoğan, A., & Canatan, H. (2015). Literature Search Consisting of the Areas of Six Sigma's Usage. Procedia - Social and Behavioral Sciences, 195, 695–704. https://doi.org/10.1016/j.sbspro.2015.06.160

Francisco Silva, A., Max Aranda Fernando Augusto Silva Marins Erica Ximenes Dias Rafael de Carvalho Miranda, K., Francisco da Silva, A., Max Aranda, K., Augusto Silva Marins, F., & Ximenes Dias Rafael de Carvalho Miranda , E. (2022). A Hybrid DMAIC Framework for Integrating Response Surface Methodology and Multi-Objective Optimization Methods. https://doi.org/10.21203/rs.3.rs-1682022/v1

Gaiardelli, P., Resta, B., & Dotti, S. (2019). Exploring the role of human factors in lean management. International Journal of Lean Six Sigma, 10 (1), 339–366. https://doi.org/10.1108/IJLSS-08-2017-0094

Guo, W., Jiang, P., Xu, L., & Peng, G. (2019). Integration of value stream mapping with DMAIC for concurrent Lean-Kaizen: A case study on an air-conditioner assembly line. Advances in Mechanical Engineering, 11 (2), 1–17. https://doi.org/10.1177/1687814019827115

Hernandez-Matias, JC, Ocampo, JR, Hidalgo, A., & Vizan, A. (2020). Lean manufacturing and operational performance: Interrelationships between human-related lean practices. Journal of Manufacturing Technology Management, 31 (2), 217–235. https://doi.org/10.1108/JMTM-04-2019-0140

Ministry of Marine Affairs and Fisheries. (2022). Export Statistics of Fishery Products for 2017-2021. Jakarta: Directorate General of Strengthening the Competitiveness of Marine and Fishery Products.

Krishna Priya, S., Jayakumar, V., & Suresh Kumar, S. (2020). Defect analysis and lean six sigma implementation experience in an automotive assembly line. Materials Today: Proceedings, 22 (xxxx), 948–958. https://doi.org/10.1016/j.matpr.2019.11.139

Kurnia, H., Jaqin, C., & Manurung, H. (2022). Implementation of the Dynamic Approach for Quality Improvement At the Elastic Tape Industry. J@ti Undip: Journal of Industrial Engineering, 17 (1), 40–51. https://doi.org/10.14710/jati.17.1.40-51

Kurnia, H., Jaqin, C., Purba, HH, & Setiawan, I. (2021). IMPLEMENTATION OF SIX SIGMA IN THE DMAIC APPROACH FOR QUALITY IMPROVEMENT IN THE KNITTING SOCKS INDUSTRY. Journal of Textiles and Engineers, 28 (124), 269–278.

Leal, JE (2020). AHP-express: A simplified version of the analytical hierarchy process method. MethodsX, 7. https://doi.org/10.1016/j.mex.2019.11.021

Liu, HC, You, JX, Li, P., & Su, Q. (2016). Failure Mode and Effect Analysis under Uncertainty: An Integrated Multiple Criteria Decision-Making Approach. IEEE Transactions on Reliability, 65 (3), 1380–1392. https://doi.org/10.1109/TR.2016.2570567

Liu, Y., Eckert, CM, & Earl, C. (2020, December 15). A review of fuzzy AHP methods for decision-making with subjective judgments. Expert Systems with Applications, Vol. 161. Elsevier Ltd. https://doi.org/10.1016/j.eswa.2020.113738

MAYANGSARI, FD, ADIANTO, H., & YUNIATI, Y. (2015). Proposed Quality Control of Insulator Products Using Failure Mode and Effect Analysis (Fmea) and Fault Tree Analysis (Fta) Methods. Bandung National Industrial Engineering, 3 (2), 81–91.

Mwaurah, PW, Kumar, S., Kumar, N., Attkan, AK, A, P., Singh, VK, & Garg, MK (2019). Novel oil extraction technologies: Process conditions, quality parameters, and optimization. Comprehensive Reviews in Food Science and Food Safety, 1 (19), 3–20. https://doi.org/10.1111/1541-4337.12507

Phadermrod, B., Crowder, RM, & Wills, GB (2019). Importance-Performance Analysis based SWOT analysis. International Journal of Information Management, 44, 194–203. https://doi.org/10.1016/j.ijinfomgt.2016.03.009

Ponsiglione, AM, Ricciardi, C., Scala, A., Fiorillo, A., Sorrentino, A., Triassi, M., ... Improta, G. (2021). Application of DMAIC Cycle and Modeling as Tools for Health Technology Assessment in a University Hospital. Journal of Healthcare Engineering, 2021. https://doi.org/10.1155/2021/8826048

Pratama, AA, Imtihan, M., & Nugroho, S. (2020). DEFECT ANALYSIS IN THE STRANDING PROCESS USING DMAIC METHOD PT. X DEFECT ANALYSIS ON STRANDING PROCESS USING DMAIC METHOD PT. X. Journal of Applied Industrial Engineering, 1 (2), 58–66. https://doi.org/10.37373/jenius.v1i2.59

Quezada. Luis E, Reinao. Eduardo A, Palominos. Pedro I, & Oddershede. Astrid M. (2019). Measuring Performance Using SWOT Analysis and Balanced Scorecard. Procedia Manufacturing, 39, 786–793.

Shahzad, U., Madaleno, M., Dagar, V., & Ghosh, S. (2022). Exploring the role of export product quality and economic complexity for economic progress of developed economies: Does institutional quality matter? 62, 40–51. https://doi.org/10.1016/j.strueco.2022.04.003

Siregar, MT (2019). Process Improvements in the Warehouse Using the DMAIC Method at PT. Dakota Logistics Indonesia. Praxis: Journal of Science, Technology, Society and Networks, 1 (2), 139–150.

Song, Y., Wu, Y., Deng, G., & Deng, P. (2020). Intermediate Imports, Institutional Environment, and Export Product Quality Upgrading: Evidence from Chinese Micro-Level Enterprises. Emerging Markets Finance and Trade, 00 (00), 1–27. https://doi.org/10.1080/1540496X.2019.1668765

Sukmaya, SG, & Saptana, S. (2021). The Impact of Trade War toward Indonesian Agriculture Export Products Product. 02001, 1–13.

Tjahjono, B., Ball, P., Vitanov, VI, Scorzafave, C., Nogueira, J., Calleja, J., … Yadav, A. (2010). Six sigma: A literature review. International Journal of Lean Six Sigma, 1 (3), 216–233. https://doi.org/10.1108/20401461011075017

Wartati, D., Garza-reyes, JA, Dieste, M., Nadeem, SP, & González-aleu, F. (2021). A Six-Sigma DMAIC Approach to Improve the Sales Process of a Technology A Six-Sigma DMAIC Approach to Improve the Sales Process of a Technology Start-Up Desy Wartati. International Journal of Mathematical, Engineering and Management Sciences, 6 (6), 1487. https://doi.org/10.33889/IJMEMS.2021.6.6.089

Yu, D., Kou, G., Xu, Z., & Shi, S. (2021, January 1). Analysis of Collaboration Evolution in AHP Research: 1982-2018. International Journal of Information Technology and Decision Making, Vol. 20, pp. 7–36. World Scientific. https://doi.org/10.1142/S0219622020500406