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Identification of Six Sigma Methodology in Fisheries Production Process Can Improve Product Quality Based on Blue Economic Prospectives

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Abstract

The achievement of national fisheries production of 18.5 million tons until the third quarter of 2023 reflects the great potential that Indonesia has in optimizing the use of its marine resources. The blue economy approach offers a sustainable growth model, utilizing marine resources wisely to improve human welfare without damaging the marine ecosystem. This study aims to identify how the Six Sigma methodology in the fisheries production process can improve product quality based on the prospective blue economy at PT. XYZ, a crab processing company in Sidoarjo, East Java. The main objective of this study is to evaluate the impact of Six Sigma implementation on product quality and the company's operational efficiency. The research methods used include case studies, analysis of production data and defect rates, and interviews with company management. The results of the study showed a significant increase in product quality, with a decrease in the defect rate from an average of 3.40% before implementation to 1.68% after implementation.

Abstrak

Capaian produksi perikanan nasional sebesar 18,5 juta ton hingga triwulan III-2023 mencerminkan potensi besar yang dimiliki Indonesia dalam optimalisasi pemanfaatan sumber daya lautnya. Pendekatan ekonomi biru menawarkan Model pertumbuhan yang berkelanjutan, memanfaatkan sumber daya laut secara bijaksana untuk meningkatkan kesejahteraan manusia tanpa merusak ekosistem laut. Penelitian ini bertujuan untuk mengidentifikasi bagaimana metodologi Six Sigma pada proses produksi perikanan dapat meningkatkan kualitas produk berdasarkan prospektif ekonomi biru pada PT. XYZ, perusahaan pengolahan rajungan di Sidoarjo, Jawa Timur. Tujuan utama penelitian ini adalah untuk mengevaluasi dampak implementasi Six Sigma terhadap kualitas produk dan efisiensi operasional perusahaan. Metode penelitian yang digunakan meliputi studi kasus, analisis data produksi dan tingkat cacat, serta wawancara dengan manajemen perusahaan. Hasil penelitian menunjukkan peningkatan signifikan dalam kualitas produk, dengan penurunan tingkat cacat dari rata-rata 3.40% sebelum implementasi menjadi 1.68% setelah implementasi.

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INTRODUCTION

The fisheries sector is one of the main foundations in the economic structure in Indonesia which plays an essential role in providing resources for economic growth and social welfare. The achievement of national fisheries production of 18.5 million tons until the third quarter of 2023 reflects the great potential that Indonesia has in optimizing the use of its marine resources. As an archipelagic country with around 65% of its territory consisting of oceans, the concept of a blue economy that advocates the sustainable use of marine resources is relevant in formulating a strategy for developing the fisheries sector. (Indonesia.go.id, 2024).

The blue economy approach offers a sustainable growth model, utilizing marine resources wisely to improve human welfare without damaging marine ecosystems. The Ministry of Marine Affairs and Fisheries (KKP) has the primary responsibility for developing Indonesia's marine and fisheries potential. Despite recording significant achievements such as fishery product exports worth USD 4.1 billion, there are still challenges to be overcome (Indonesia.go.id, 2024).

The fisheries production process has a significant impact on improving quality and efficiency. One interesting aspect to study is the process of handling and storing the catch, especially in the early stages after the fish are caught from the waters. This process has a direct influence on the quality and freshness of the fish produced, which has an impact on the selling value and competitiveness of fishery products. By applying the Six Sigma methodology to this process, it is hoped that it can improve efficiency and quality, while supporting the sustainability of fish resources and the conservation of vulnerable marine ecosystems.

Thus, this study aims to explore the implementation of the Six Sigma methodology on the quality and efficiency aspects of fisheries production. It is expected that this study can provide valuable insights for the future development of the Indonesian fisheries sector. With a holistic and integrated approach between the Six Sigma methodology and the blue economy concept, it is expected that innovative solutions can be found that can improve the quality of fisheries products while still paying attention to the sustainability of the economy and the marine environment. These steps are expected to support the vision of sustainable development of the Indonesian fisheries sector, as well as provide a positive contribution to economic growth and the welfare of coastal communities. The purpose of this study is to identify how the Six Sigma methodology in the fisheries production process can improve product quality.

LITERATURE REVIEW

Six Sigma is a comprehensive and flexible system for achieving, sustaining and maximizing business success (Pande & Cavanagh, 2002). This system is managed with a deep understanding of facts, data, and statistical analysis, as well as attention to detail in managing, improving, and strengthening business processes. Six Sigma aims to achieve a quality level with a target of 3.4 failures per million opportunities in every transaction of goods and services products. Thus, Six Sigma is an innovative method or technique in product control and improvement, offering a new approach in quality management to achieve, maintain, and optimize business success (Gasperz, 2003).

Blue Economy is a concept that aims to optimize the use of aquatic resources with the aim of increasing economic growth through various innovative and creative activities, but still paying attention to business sustainability and environmental preservation. This concept emphasizes the importance of efficiency in the use of resources, which encourages investment and business development in the fisheries sector while preserving the environment. The core of the Blue Economy concept is to prioritize activities that support the ecosystem and are sustainable (Ilma, 2017).

From the above description, it can be concluded that the essence of the Blue Economy concept is as follows:

1. Learning from nature: Blue Economy adopts the way nature (ecosystem) works by working in accordance with natural resources efficiently and trying to enrich nature, not destroy it.
2. Ecosystem logic: This concept follows the principles of the ecosystem where nutrients and energy flow naturally to meet the needs of all living things. Waste from one organism becomes a source of energy for other organisms, creating balance in the ecosystem. Blue Economy aims to support the life system by distributing energy efficiently and evenly without relying on external resources.
3. Innovation and Creativity: Blue Economy encourages practical economic innovation by utilizing the efficiency of the ecosystem to flow nutrients and energy without leaving waste. This concept utilizes the ability of all contributors in the ecosystem to meet the basic needs of all living things.

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Overall, Blue Economy aims to create sustainable economic growth while ensuring ecological and social sustainability. Blue Economy can be considered as an economic model that promotes sustainable development by considering the principles of natural ecosystems.

The implementation of sustainable development through green products and services does not always go as expected. This is because green products and services often have to be purchased at a higher price, making them unaffordable for the poor because they require greater investment. The additional costs incurred by investors to produce these green products and services are ultimately passed on to consumers (Pauli, 2010).

1	Title	Product Quality Control Analysis Using Six Sigma and Kaizen Methods (Case Study: PT XYZ)
	Author	(Ashari & Nugroho, 2022)
	Summary	This study discusses the implementation of Six Sigma and Kaizen Methodology in controlling product quality at PT XYZ, especially in the Mill 1 production process. In this study, the company faced the problem of high defect rates in the initial components produced. Through the analysis of Actual Defect Per Unit (DPU) and DMAIC steps of Six Sigma, this study successfully identified the main causes of defects and increased the company's sigma value to compete in the market. In addition, the Kaizen approach was also applied as an effort to continuously improve the production process.
	Relevance	This study is relevant to the title "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of Fisheries Production Based on the Prospective Blue Economy" because it provides practical insight into the application of Six Sigma Methodology in the context of industrial production, which can be directly applied in the fisheries sector. Through the implementation of DMAIC and the Kaizen approach, this study not only aims to improve product quality, but also to improve operational efficiency, which is an important aspect in efforts to achieve blue economic sustainability. Thus, this study provides a direct contribution to the understanding of how the Six Sigma and Kaizen approaches can be used in the fisheries industry to support sustainable economic growth and improve product quality by considering the blue economy aspect.
2	Title	Analysis of Six Sigma Implementation in Green Supply Chain Quality Control of Diesel Oil Distribution
	Author	(Saftriani, Nugraha, & Irmawati, 2023)
	Summary	This study evaluates the application of Six Sigma Methodology in controlling the quality of green supply chain of diesel oil distribution at PT Nusantara Samudera Gemilang. By using the DMAIC (Define, Measure, Analyze, Improve, and Control) method from Six Sigma, this study identifies the types of defects in the diesel oil distribution process and evaluates the constraints that affect the quality of the green supply chain. One of the defects found is a diesel oil spill, which has a negative impact on the environment and the company's logistics costs. Through the application of DMAIC, it is expected that the company can identify, analyze, and fix existing problems to achieve a lower level of process defects or even achieve a zero defect level, so that it can create an optimal green supply chain.
	Relevance	This study provides additional insights into the application of Six Sigma Methodology in the context of green supply chain, which is directly relevant to the title "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of

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		Fisheries Production Based on Blue Economy Prospects". Although the focus is on the diesel oil industry, the principles and methodologies used in this study can be applied in the context of fisheries production to improve product quality and operational efficiency, in accordance with the vision of a sustainable blue economy. Thus, this study can provide additional insights into how the Six Sigma approach can be applied in the fisheries industry to support the sustainability of the blue economy.
3	Title	Analysis of Quality Control in Palm Oil Processing with the Six Sigma Method at PT Suryabumi Agrolanggeng
	Author	(Rismantia & Setiafindari, 2022)
	Summary	This study evaluates the application of Six Sigma Methodology in quality control in palm oil processing at PT Suryabumi Agrolanggeng. The company faces the problem of defective CPO (Crude Palm Oil) products due to defects in raw materials, namely Fresh Fruit Bunches (FFB), with defect fractions F00, F0, and F5. The Six Sigma method is used to measure and eliminate defects with a focus on understanding, measuring, and improving the process. The analysis was carried out using the DMAIC (Define, Measure, Analyze, Improve, and Control) approach, where defect fraction 0 was identified as the most dominant. Factors that cause defects include humans, materials, machines, and the environment.
	Relevance	This study is relevant to the title "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of Fisheries Production Based on the Prospective Blue Economy". Although the focus is on the palm oil industry, the concepts and approaches used in this study can be applied in the context of fisheries production. Through an understanding of the factors causing defects and the use of the Six Sigma Methodology, companies can improve product quality and operational efficiency, in accordance with the principles of a sustainable blue economy. Thus, this study provides additional insight into how the Six Sigma approach can be used in the fisheries industry to support sustainable economic growth and improve product quality by considering the blue economy aspect.
4	Title	Analysis of Fish Production Quality Control Using the Six Sigma Method to Reduce the Number of Product Defects
	Author	(Musa & Suseno, 2022)
	Summary	This study uses the Six Sigma Method, especially the DMAIC stage, to control the quality of fish production at PT Patria Perikanan Lestari Indonesia. Through analysis using quality control tools from Seven Tools, the company seeks to reduce the number of product defects and waste in the tuna fish production process. The focus of quality control is on the materials, production processes, and machines used. Literature studies show that quality control is also related to the type of defect in the product and the number of products that experience defects in a certain period. The DMAIC method is used to identify the causes of product defects and plan improvements.
	Relevance	This study is relevant to the title "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of Fisheries Production Based on the Prospective Blue Economy" because it provides a practical perspective on the application of Six Sigma Methodology in controlling the quality of fish

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		production. Although the focus is different from fisheries production directly, the concepts used in this study can be easily applied in the fisheries industry. By using DMAIC and Six Sigma principles, companies can reduce the number of product defects and improve operational efficiency, which is in line with the goal of a sustainable blue economy. Therefore, this study provides additional insight into how the Six Sigma approach can be applied in the fisheries industry to improve product quality and support sustainable economic growth.
5	Title	Techno-Economic Analysis of Tuna Waste Utilization Based on Blue Economy in Jayapura City
	Author	(Hutajulu, Marlianingrum, Lobo, & Haryati, 2021)
	Summary	This study aims to analyze the technology and economics of utilizing yellowfin tuna waste as organic fish feed in Jayapura City. The results of the analysis indicate that processing tuna waste into fish feed has the potential to provide significant benefits and can be an alternative source of livelihood for the community. In addition, tuna waste management can be developed into a Micro, Small, and Medium Enterprise (MSME) based on the blue economy, which aims to support efficient and sustainable regional development. This study highlights the importance of using fish waste as an alternative feed raw material to replace fish meal in feed, thereby minimizing adverse impacts on the environment and providing significant economic benefits.
	Relevance	This study is relevant to the title "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of Fisheries Production Based on the Prospective Blue Economy". Although the focus is different, both studies reflect the concept of a sustainable blue economy in the context of the fisheries industry. Research on the utilization of fish waste as raw material for feed reflects efforts to utilize resources efficiently and sustainably, while research on the application of the Six Sigma Methodology aims to improve the efficiency and quality of fisheries production. Thus, both studies complement each other in supporting the development of a fisheries industry that is economically and environmentally sustainable.
6	Title	Implementation of the Blue Economy Concept in Coastal Community Development in Sabang City
	Author	(Setyawati, et al., 2021)
	Summary	This article discusses the implementation of the blue economy concept in coastal community development in Sabang City. The blue economy concept is seen as a solution to align economic interests with marine environmental sustainability. This study identifies the potential of the blue economy in Sabang City, reviews the role of conservation areas in nature conservation, and analyzes the positive impacts of the blue economy on improving the welfare of coastal communities. By considering government regulations that include the blue economy as part of Indonesia's marine policy, this article emphasizes the importance of assessing the potential and implementation of the blue economy concept in coastal and marine areas of Sabang City.
	Relevance	This study is relevant to the title "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of Fisheries Production Based on the Prospective Blue Economy".

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		Although the focus is different, both highlight the importance of sustainable development in coastal areas, considering economic and environmental aspects. The study of the implementation of the blue economy concept in Sabang City reflects an effort to understand how the concept can be applied in the context of coastal community development, while research on the application of the Six Sigma Methodology aims to improve the efficiency and quality of fisheries production. Thus, both can complement each other in supporting the development of a fisheries industry that is economically and environmentally sustainable.
7	Title	Product Quality Optimization and Production Efficiency with Six Sigma Method at PT. Sumber Rubberindo Jaya
	Author	(Pangastuti, Zahila, & Satoto, 2022)
	Summary	PT. Sumber Rubberindo Jaya is a rubber manufacturer that produces motorcycle tires and inner tubes. Product quality is key in business competition, and the Six Sigma concept is used as an approach to achieve high quality. This study identifies the causes of product defects, such as excess tire weight and inappropriate physical conditions, and applies the Six Sigma method to improve production efficiency and reduce product defects.
	Relevance	This study is relevant to the title "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of Fisheries Production Based on the Prospective Blue Economy." Although the objects of research are different, both focus on the application of the Six Sigma Method to improve the quality and efficiency of production in different industrial contexts. The implementation of Six Sigma at PT. Sumber Rubberindo Jaya aims to improve the quality of rubber products, while research on sustainable fisheries production aims to improve the quality and efficiency of fisheries production based on the blue economy. Thus, both can provide valuable insights into the application of Six Sigma principles in various industries to achieve quality and efficiency goals.
8.	Title	Implementation of Lean Six Sigma in the Implementation of Supply Chain Management at Samsung Company
	Author	(Octavia, 2022)
	Summary	This study discusses the application of Lean Six Sigma in Samsung's Supply Chain Management (SCM). SCM is a centralized management of the flow of goods and services from raw materials to finished products. Samsung uses Six Sigma as part of their innovation to better understand consumer needs and improve consumer satisfaction. This study highlights the importance of coordination between the company and its suppliers in meeting market and consumer needs and improving the distribution process to consumers.
	Relevance	This study is relevant to the title "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of Fisheries Production Based on the Prospective Blue Economy." Although focusing on a different industry, namely Samsung company in supply chain management, the concept of Lean Six Sigma used to improve efficiency and customer satisfaction can provide valuable insights in the context of the application of Six Sigma methodology in various industrial sectors. Be it in fisheries production or supply chain management, the Lean Six

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		Sigma approach aims to improve quality, efficiency, and customer satisfaction, which is in accordance with the principles of the blue economy for sustainable development.
9.	Title	Pengendalian Kualitas Produksi dengan Menggunakan Metode *Six Sigma*
	Author	(Aulawi & Maulana, 2019)
	Summary	This study discusses production quality control using the Six Sigma method. PT. Mandala Logam Utama, a company that produces various rubber products, faces problems with defective products and wasted time in the production process. Production data shows a high percentage of defective products, which affects production efficiency and costs. Through the analysis of defects and waste in the production process, this study focuses on identifying and improving the causes of product defects, with the aim of improving product quality and production process efficiency.
	Relevance	This study is relevant to the topic "Study of the Application of Six Sigma Methodology on the Quality and Efficiency of Fisheries Production Based on the Prospective Blue Economy." Although focusing on a different industry, namely the rubber processing industry, the concept of production quality control using the Six Sigma method can provide valuable insights in improving production efficiency and quality in the context of fisheries or other industries. The quality control measures described in this study can be applied to reduce product defect rates and minimize time wastage in the production process, which is in accordance with the principles of the blue economy for sustainable development.
10.	Title	Improving Product Quality and Minimizing Waste Using the Six Sigma Approach in Animal Feed Companies
	Author	(Muhammad, Winarso, & Lumintu, 2020)
	Summary	This study discusses the application of the Six Sigma approach to improve product quality and reduce waste in a livestock feed company. The company faced product defects caused by the production process and raw material storage. Through the Define, Measure, and Analyze steps, significant defects were identified, including defects with lice attributes in the production process and inventory. Recommendations for improvement include installing blowers and air temperature control in storage, experimenting for the best raw material selection, and improving cleaning scheduling. Product quality is an important factor for both customers and companies in maintaining their competitiveness in a competitive market.
	Relevance	This research is relevant to the topic of "Improving Quality and Production Efficiency with Six Sigma Approach in Sustainable Fisheries Industry." Although the focus is on the animal feed industry, the concept of implementing Six Sigma to improve product quality and reduce waste can be applied in the fisheries context to achieve the blue economy goals. The improvement strategies proposed in this study can provide useful insights for fisheries companies in improving the efficiency of their production processes and product quality.

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METHOD

This study adopts a systematic quantitative approach to collect and analyze data related to the implementation of Six Sigma in the fisheries industry. This approach allows researchers to measure the variables that have been set in the conceptual framework of the study in an objective and structured manner. By using the right research strategy, it is expected that this study can provide an in-depth understanding of the factors that influence the success of Six Sigma implementation in the fisheries industry

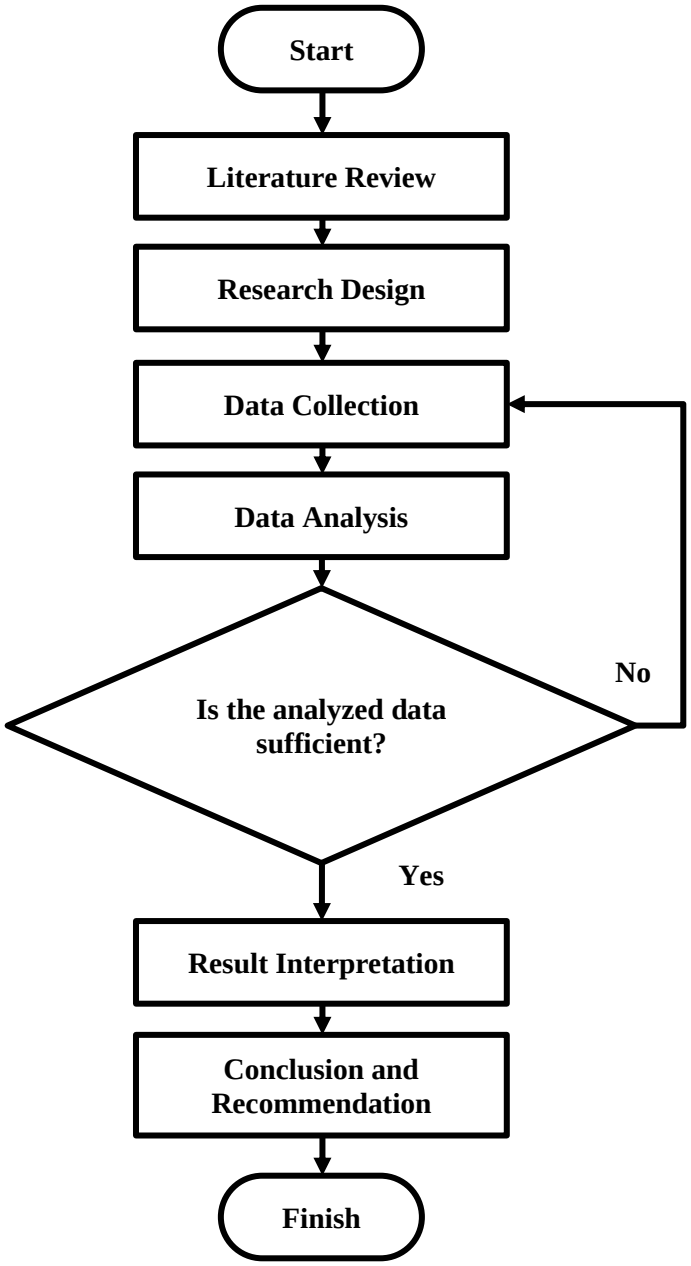

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Figure 3.1 *Research Flow Chart*

The collected data will be analyzed using various descriptive and inferential statistical techniques. Descriptive analysis will be used to analyze the distribution of variables, central tendencies, and variations in the data. Inferential techniques, such as regression analysis and hypothesis testing, will be used to test the relationship between variables and check for the presence of Moderator or mediator effects. By using the right analysis method, it is expected that this study can provide valid and reliable results, and make a significant contribution to the understanding of Six Sigma implementation in the fisheries industry.

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RESULTS AND DISCUSSION

PT. XYZ is a company engaged in the industry of fish and aquatic biota management and preservation in cans, with a primary focus on pasteurized crab meat products. The company was founded in 2011 and began operating in the same year. PT. XYZ produces pasteurized crab meat products by implementing food safety principles that ensure the products are safe for consumption. The products produced vary based on the type of crab meat. On average, the company produces around 800 kg of products per day. As much as 98% of PT. XYZ's products are exported to America, Canada, and Malaysia, while the remaining 2% are sold in the local market. The various types of products produced can be seen in Table 1.

Tabel 1. PT. XYZ Product

Product Type	Product Description
Colossal	Contains jumbo lump meat with a size of more than 9 grams/pcs
Jumbo Lump	Contains jumbo lump meat measuring 3.5 – 8.5 grams/pcs
Super Lump	Contains a mixture of jumbo lump, regular large pieces of meat, and decorated with flowers on the top and bottom.
Backfin	Contains a mixture of large regular meat and small regular meat. The amount of large regular meat is more than small regular meat according to buyer's request
Lump	Contains a mixture of large regular meat and small regular meat. The amount of small regular meat is more than large regular meat according to the buyer's request
Special	Contains 100% regular small meat
Claw	Contains a mixture of merus, carpus, and cocktail claw meat

Source: PT. XYZ (2022)

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Six Sigma Tools and Techniques Used

The implementation of the Six Sigma methodology at PT. XYZ is supported by various tools and techniques designed to improve product quality and process efficiency. Here are some of the Six Sigma tools and techniques used:

1. DMAIC (Define, Measure, Analyze, Improve, Control): DMAIC is a five-stage-based methodology used to solve problems and optimize processes. The stages of DMAIC at PT. XYZ include:
    - Define: Clearly define the project objectives and identify the key problems to be solved.
    - Measure: Measure current process performance using relevant data and metrics.
    - Analyze: Analyze data to identify root causes of problems using tools such as Pareto analysis, Fishbone diagrams, and statistical techniques.
    - Improve: Develop effective solutions based on data analysis to improve the process.
    - Control: Establish controls and metrics to monitor and maintain improvements that have been made.
2. Statistical Process Control (SPC): SPC is used to monitor and control the quality of the production process by analyzing data statistically. PT. XYZ uses control charts to detect unwanted variations in the crab production process.
3. Fishbone Diagram (Ishikawa):Fishbone Diagram is used to identify factors that influence a particular problem. PT. XYZ uses this diagram for root cause anal ysis and solution identification.
4. Pareto Analysis: Pareto analysis is used to identify problems or factors that have the most influence on process results. This analysis helps PT. XYZ prioritize improvements that have the greatest impact.
5. Failure Mode and Effects Analysis (FMEA): FMEA is used to analyze potential failures in the production process and identify preventive measures that can be taken. PT. XYZ uses FMEA to improve the reliability and safety of the crab production process.
6. Statistical Tools (Tools of Analysis):Various statistical tools such as regression analysis, analysis of variance (ANOVA), hypothesis testing, and logistic regression analysis are used to support data analysis and evidence-based decision making at PT. XYZ.
7. Quality Function Deployment (QFD): QFD is used to link customer needs with product or process characteristics. PT. XYZ implements QFD to ensure that their crab products meet customer expectations and needs in the international market.
8. Control Charts: Control charts are used to monitor the variability of the production process over time. PT. XYZ uses Control charts to keep the crab production process within predetermined control limits.

Product Quality Evaluation

The implementation of the Six Sigma methodology at PT. XYZ has significantly affected the quality of the crab products produced. Evaluation of product quality before and after the implementation of Six Sigma was carried out to assess the changes and improvements that had been achieved.

Product Defect Rate

The product defect rate refers to the number or percentage of products that do not meet the established quality standards. In the context of the implementation of Six Sigma at PT. XYZ, the product defect rate is an important parameter to evaluate. Six Sigma aims to reduce variability in the production process so that the defect rate can be minimized or even eliminated completely.

The following is a report on the product defect rate before and after implementation.

Table 2 Product Defect Rate Report Data Before Implementation

Year	Production Quantity (kg)	Defective Quantity (kg)	Defective Rate (%)
2011	251,246	8,741	3.48
2012	289,573	9,865	3.41
2013	312,987	10,502	3.36
2014	275,419	9,214	3.34
2015	298,624	9,975	3.34

Sumber: Laporan Tingkat Cacat Produk PT. XYZ (2011-2015)

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Table 3 Product Defect Level Report Data After Implementation

Year	*Production Quantity (kg)*	*Defective Quantity (kg)*	*Defective Rate (%)*
2016	305,712	6,428	2.10
2017	321,865	5,932	1.84
2018	335,421	5,276	1.57
2019	312,589	4,981	1.59
2020	298,342	4,632	1.55
2021	310,876	4,813	1.55
2022	325,674	4,297	1.32
2023	331,567	4,121	1.24

Source: PT. XYZ Product Variability Report (2016-2023)

Based on the data above, Before the implementation of Six Sigma, PT. XYZ faced challenges in the quality of crab products, especially related to the relatively high defect rate. Based on historical data before 2015, the defect rate ranged from 3.34% to 3.48% of total production. Although the amount of crab production increased from year to year, the variation in the defect rate indicated the consistency of the problem in product quality. After implementing Six Sigma starting in 2015, PT. XYZ experienced significant improvements in the defect rate of their crab products.

Data recorded from 2016 to 2023 showed a consistent decrease in the defect rate. In 2016, the defect rate dropped drastically from 3.34% to 2.10%. Then, there was a further decrease from year to year, with the defect rate reaching its lowest point of 1.24% in 2023. Although the amount of production continued to increase, the implementation of Six Sigma helped reduce the number of defects produced, reflecting improvements in the production process and quality control.

Product Variability

Variability in the context of taste, texture, and size of crab products refers to the degree of difference or variation that occurs in these attributes among products produced. Significant variability can result in discrepancies between products in terms of characteristics such as inconsistent taste, varying textures, or non-uniform size.

The implementation of the Six Sigma methodology aims to reduce this variability by systematically identifying sources of variability in the production process. Through process analysis and improvement, Six Sigma can help PT. XYZ achieve greater consistency in the taste, texture, and size of their crab products. By reducing this variability, the company can increase customer satisfaction and meet more consistent expectations for their products.

The following is a report on Product Variability before and after implementation.

Table 4 Product Variability Report Data Before Implementation

Year	Taste Variability (%)	Texture Variability (%)	Size Variability (%)
2011	8.2	7.5	6.9
2012	7.8	7.1	6.5
2013	8.0	6.9	6.3
2014	7.5	6.8	6.1
2015	7.3	6.5	5.8

Source: PT. XYZ Product Variability Report (2016-2023)

Table 5 Product Variability Report Data After Implementation

Year	Taste Variability (%)	Texture Variability (%)	Size Variability (%)
2016	3.5	3.2	2.8
2017	3.3	3.0	2.7
2018	3.0	2.8	2.5
2019	2.8	2.6	2.3
2020	2.7	2.5	2.2
2021	2.6	2.4	2.1
2022	2.5	2.3	2.0

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2023	2.4	2.2	1.9

Source: PT. XYZ Product Variability Report (2016-2023)

Based on the data above, before the implementation of Six Sigma, PT. XYZ faced major challenges in managing the variability of their crab products. Variability in taste, texture, and size of the product was relatively high, reflecting inconsistencies in the production process and quality control. Data from 2011 to 2015 showed that taste variability ranged from 7.3% to 8.2%, texture variability between 6.5% to 7.5%, and size variability between 5.8% to 6.9%. This resulted in inconsistent product taste, significant texture variation, and size deviations that affected consumer experience and customer satisfaction. Records from this period also showed customer complaints related to unstable taste and large size variations, indicating that challenges in maintaining product consistency affected the company's reputation and operational efficiency.

After the implementation of Six Sigma in 2015, PT. XYZ saw significant improvements in the consistency and quality of their crab products. Variability in taste decreased significantly from 8.2% in 2011 to 2.4% in 2023. Similarly, texture variability decreased from 7.5% to 2.2%, and size variability from 6.9% to 1.9% during the same period. These decreases reflect improvements in production processes and better quality control, which are the result of the implementation of Six Sigma methodology that focuses on identifying and eliminating the causes of variability. Records during this period show better stability in taste, more consistent texture, and better control of product size, all of which contribute to increased customer satisfaction and strengthening the company's position in the market.

CONCLUSIONS AND SUGGESTION

The implementation of Six Sigma in the fisheries production process at PT. XYZ has succeeded in improving the quality of crab products. By identifying and reducing variability in the production process, the company can produce products that are more consistent in terms of taste, texture, and size. This is evidenced by the significant decrease in the level of product defects from before implementation (average 3.40%) to after implementation (average 1.68%) of Six Sigma.

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