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ADAPTING STATISTICAL QUALITY CONTROL FOR THE SEAFOOD PROCESSING INDUSTRY IN PAPUA: A LITERATURE REVIEW FOR DEVELOPING A SUSTAINABLE QUALITY CONTROL MODEL

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ABSTRACT

The seafood processing industry in Papua, Indonesia, faces unique challenges in maintaining consistent product quality due to geographical remoteness, logistical complexities, and the perishable nature of marine resources. This research conducts a comprehensive literature review to explore the potential adaptation of Statistical Quality Control methodologies for enhancing quality control practices within this industry, with a focus on developing a sustainable quality control model that addresses the specific needs and constraints of the region. By examining existing literature on SQC applications in food processing, cold chain management, and risk assessment, this study aims to identify best practices, relevant tools, and critical success factors for implementing effective and sustainable quality control measures that ensure product safety, reduce waste, and promote economic growth in the Papuan seafood sector.

Keywords: Statistical Quality Control, Seafood Processing, Sustainable Quality Control, Literature Review.

1. INTRODUCTION

The seafood processing industry in Papua holds significant economic and social importance, necessitating improvements in quality and productivity within the local context (Kirby et al., 2025). Statistical Quality Control offers a strategic framework for ensuring product excellence, customer satisfaction, and adherence to regulatory standards in this sector (Ginting & Supriadi, 2021; Kirby et al., 2025). Quality management systems, such as Total Quality Management, Lean Construction, and ISO9000 standards, have been adopted globally to enhance productivity and quality, demonstrating their effectiveness (Kirby et al., 2025). However, the successful implementation of quality control systems requires careful consideration of the specific challenges and opportunities present in the Papuan seafood processing industry. These challenges may include the remoteness of the region, limited infrastructure, varying levels of technological adoption, and the need to integrate traditional practices with modern quality control methodologies. Applying Statistical Quality Control methodologies, encompassing tools and techniques for monitoring and evaluating process variability, to the seafood processing sector can lead to notable enhancements in product quality and operational efficiency (Arianti et al., 2020). Statistical process control is a robust methodology to determine if the production process is under control (Gozali et al., 2020). Statistical Quality Control can play a key role in optimizing processes within seafood industry (Valdokhina,

2019). By adopting a systematic method to identify and address the root causes of defects, businesses can significantly reduce waste, improve product consistency, and increase profitability (Sharma & Rao, 2013).

The application of Hazard Analysis and Critical Control Points principles is vital for mitigating risks related to food safety in the seafood industry (Liu et al., 2020). The goal of this research is to determine how Statistical Quality Control principles can be successfully incorporated into Papua's seafood processing sector, paving the way for a sustainable quality control model. Implementing Statistical Quality Control necessitates a holistic approach that considers organizational culture, employee training, and technological infrastructure (Kirby et al., 2025). Businesses can facilitate a culture of continuous improvement by empowering employees to actively participate in quality control activities. Moreover, investing in training programs that equip personnel with the skills to interpret statistical data, implement control charts, and conduct root cause analysis is essential for sustained success. Furthermore, the integration of Statistical Quality Control with digital technologies, such as data analytics software and real-time monitoring systems, can enhance the efficiency and effectiveness of quality control processes. The implementation of a Hazard Analysis and Critical Control Points-based system leads to failure costs reduction, quality improvement, and a better understanding of production planning and control (Lupín et al., 2010). HACCP is an effective management tool in ensuring the safety of finished food products (Liu et al., 2020). It also provides significant protection for both consumers and companies (Liu et al., 2020; Wang & Zhang, 2024). Firms that acquire certifications such as HACCP may benefit from enhanced safety, increased sales growth, improved labor productivity, and greater profitability (Liu et al., 2020).

This literature review aims to explore existing research on Statistical Quality Control methodologies and their application in the food and seafood industries, with a specific focus on identifying best practices and adaptable strategies for the Papuan context. This research seeks to integrate modern innovations in food safety management to improve the traditional HACCP system (Ukwuru, 2018). By analyzing successful case studies and research findings, this review will provide insights into the key factors that contribute to the successful implementation of Statistical Quality Control in the seafood processing industry. The integration of HACCP with Statistical Process Control aids in data-driven decision-making (Kharub, 2020). The ultimate goal is to provide a comprehensive framework for developing a sustainable quality control model that not only enhances product quality and safety but also promotes economic growth and environmental sustainability in the Papuan seafood processing sector. HACCP implementation ensures adherence to safety standards through continuous monitoring and corrective actions, supported by thorough documentation and regular verification (Ibrahim, 2020).

2. METHOD

A comprehensive literature review was conducted to gather relevant information on Statistical Quality Control methodologies and their application in the food and seafood processing industries. The literature review encompassed scientific articles, industry reports, conference papers, and other scholarly sources relevant to the research topic. The initial search was conducted using online databases such as Scopus, Web of Science, and Google Scholar, with a focus on identifying studies that explored the application of Statistical Quality Control in the food and seafood sectors. The review focused on studies that reported on the implementation of HACCP and its impact on food manufacturers (Liu et al., 2020). Relevant keywords and search terms included "Statistical Quality Control," "seafood processing," "quality management," "HACCP," "control charts," "process capability analysis," and "Papua seafood industry." The search strategy was refined iteratively to ensure that all relevant studies were identified. Additionally, a review of relevant industry reports and publications was conducted to gather information on the specific challenges and opportunities facing the Papuan seafood processing industry.

The selected studies were then critically appraised to assess their methodological rigor, validity, and relevance to the research question. This involved evaluating the study design, sample size, data collection methods, statistical analysis techniques, and the generalizability of the findings. Emphasis was given to studies that provided detailed descriptions of the Statistical Quality Control methodologies used, the implementation process, and the resulting impact on product quality and process efficiency. Data extraction involved systematically recording key information from each selected study, including the study objectives,

research design, sample characteristics, Statistical Quality Control methodologies used, key findings, and conclusions. The extracted data was then synthesized and analyzed to identify common themes, patterns, and best practices related to the application of Statistical Quality Control in the food and seafood processing industries.

3. RESULT AND DISCUSSION

Table 1. Summary of Key Findings on the Integration of Statistical Quality Control in the Seafood Processing Industry in Papua

No	Component	Description
1	Objective	Assess the food control system focusing on five key components using literature review and surveys from food safety organizations.
2	HACCP Definition	Hazard Analysis and Critical Control Points (HACCP) is a certification aimed at preventing food safety hazards, improving safety, sales growth, productivity, and profits in food firms (Liu et al., 2020).
3	Statistical Quality Control (SQC)	Application of statistical methods to manage and maintain product and service quality, preventing defects, and reducing variation in processes (Ibrahim, 2020).
4	Quality Control Responsibilities	Establishing and validating quality control procedures, maintaining product reference standards, and participating in environmental monitoring (Ukwuru, 2018).
5	Real-time Monitoring	Essential for minimizing defects and ensuring adherence to quality standards. Integration of SQC within HACCP frameworks allows for data-driven decision-making and operational efficiency (Lee et al., 2023).
6	Methodologies Used	Control charts and process capability analysis to monitor critical control points, enhance safety, and reduce waste (Zugarramurdi et al., 2007; Wang & Zhang, 2024).
7	Integration Benefits	The combined application of SQC and HACCP provides a robust framework for ensuring seafood product quality and safety, enhancing competitiveness, and contributing to economic development in Papua.
8	Conclusion	Integrating SQC methodologies into HACCP frameworks presents a promising avenue for enhancing quality management in the Papuan seafood processing industry, promoting sustainable practices and improving overall product quality.

The objective of this research paper was to assess the food control system with in depth examination of five key components using desktop analysis and short survey from related food safety program organizations including regulators and inspectors (Lin & Yamao, 2012). HACCP is an institutionalized certification whose goal is to prevent food safety hazards (Liu et al., 2020). The implementation of HACCP helps food firms improve safety, increase sales growth, improve labor productivity, and increase profits. Statistical quality control systems are used in production to manage and maintain quality levels. Statistical quality control is the application of statistical methods to regulate and maintain the quality of products and services. Statistical quality control is the application of statistical techniques for measuring and improving the quality of processes (Ibrahim, 2020). Statistical quality control is a set of statistical tools and techniques used to monitor and control the quality of products and services. Statistical quality control is a proactive system of controlling all aspects of food safety, making it desirable to food manufacturers, retailers, food service providers, and worldwide food regulation agencies (Ibrahim, 2020). The application of statistical process control is an effective technique to prevent the causes of defects through process monitoring, defect prevention and reduction of variation.

Quality control departments have a variety of responsibilities, including establishing, validating, and implementing quality control procedures, assessing, maintaining, and storing product reference standards to ensure the stability of active food ingredients and products, and participating in environmental monitoring (Ukwuru, 2018). The quality of any product can be assured through a variety of analytical techniques. The implementation of quality control programs results in better-quality products and higher levels of customer satisfaction (Wang & Zhang, 2024). Quality control comprises testing of units and determining whether they are within the specifications for the final product. The purpose of testing is to determine any needs for corrective actions in the manufacturing process. By focusing on real-time monitoring and immediate corrective actions, seafood processors can minimize the risk of defects and ensure consistent adherence to quality standards (Liu, 2018).

In Papua's seafood processing industry, the integration of Statistical Quality Control within HACCP frameworks presents a novel approach to quality management (Lee et al., 2023). By employing statistical methods, businesses can monitor production processes, preemptively identify deviations, and implement corrective measures, thereby mitigating the potential for producing substandard products (Pisarciuc, 2016). The application of Statistical Quality Control methodologies, such as control charts and process capability analysis, enables seafood processors to monitor critical control points more effectively and make data-driven decisions (Zugarramurdi et al., 2007). This proactive approach not only ensures product safety but also enhances operational efficiency by reducing waste and minimizing the risk of product recalls (Wang & Zhang, 2024).

Moreover, the statistical stability and capability of production processes can be studied by interpreting data and graph trends, forecasting critical quality attributes, and analyzing sigma process capability (Chopra et al., 2012). HACCP provides a systematic approach to identifying and controlling hazards, ensuring that food safety is not compromised at any stage of the process (Goodrich et al., 2019; Ibrahim, 2020; “Implementation of HACCP in A Food Processing Plant,” 1993). The combined efforts of HACCP and quality assurance control points, such as improved food hygiene, can further enhance and sustain both quality and safety levels (Okpala & Korzeniowska, 2021).Statistical Quality Control, when integrated with HACCP, provides a robust framework for ensuring the quality and safety of seafood products in Papua.

4. CONCLUSION

This literature review provides a comprehensive overview of the potential benefits of integrating Statistical Quality Control methodologies into HACCP frameworks in the Papuan seafood processing industry. By embracing Statistical Quality Control, seafood processors can enhance product quality, improve process efficiency, and strengthen their market competitiveness. This study provides useful information to scholars to better understand process quality of tablet production and study the relations between variables.

The integration of HACCP and SPC enhances hazard control and promotes continuous process improvement. Effective implementation of statistical process control technology leads to quality management that shifts from passive after-checking to active pre-prevention in the process (Kharub, 2020; Li, 2021). Statistical quality control implementation can reduce defects in products, process irregularities needing rectification, and enhancement of safety and quality standards (Lee et al., 2023).

The integration of Statistical Quality Control methodologies into HACCP frameworks presents a promising avenue for enhancing quality management in the Papuan seafood processing industry, contributing to the region's economic development and sustainability.

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