

# **Improving Export Competitiveness in the Peruvian Fisheries Sector through a Standardized Operational Management Model**

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## **Abstract**

The fisheries sector plays a strategic role in the Peruvian economy due to its contribution to employment, exports, and value generation. In recent years, fisheries and related activities have accounted for approximately 0.8% of national GDP and generated more than 380,000 direct and indirect jobs, while fishery exports exceeded USD 3.6 billion, representing nearly 5% of total national exports. Despite its economic relevance, export competitiveness in the sector remains constrained by sustainability challenges, inconsistent product quality, and limited operational standardization, particularly under increasingly strict international market requirements related to traceability, environmental impact, and quality compliance. This study aims to strengthen export competitiveness in the Peruvian fisheries sector through the application of Industrial Engineering principles. A qualitative and analytical research approach was adopted, combining a PESTE analysis and an Importance–Governance (IGO) matrix to identify and prioritize key competitiveness factors. Based on the diagnostic results, a Standardized Operational Management Model (SOMM) is proposed, integrating standardized work, selective fishing technologies, and KPI-based performance measurement. The results identify sustainability of fishing resources and product quality as the most critical and governable drivers of competitiveness. The proposed SOMM provides a structured and operationally feasible framework to translate strategic sustainability and quality objectives into measurable operational practices, contributing to improved export performance and long-term sector competitiveness.

## **Keywords**

Fisheries sector, export competitiveness, standardized work, sustainability, industrial engineering.

## **1. Introduction**

The fisheries sector represents a strategic pillar of the Peruvian economy due to its contribution to employment generation, export revenues, and food supply. According to official sectoral statistics, fisheries and aquaculture activities contribute approximately 0.8% of national gross domestic product (GDP) and generate more than 380,000 direct and indirect jobs nationwide. In addition, fishery exports have exceeded USD 3.6 billion annually in recent years, accounting for nearly 5% of total national exports and positioning Peru as a relevant supplier in global seafood markets (Ministerio de la Producción, 2025).

Despite its economic importance, the export competitiveness of the Peruvian fisheries sector faces persistent challenges. International markets impose increasingly stringent requirements related to sustainability, traceability, product quality, and regulatory compliance, which create significant barriers for fisheries operations characterized by weak operational controls and limited standardization (OECD & FAO, 2025). Although recent reports indicate a partial recovery in export volumes, competitiveness gaps remain, particularly in the development of value-added products and in consistent compliance with international standards (Ministerio de la Producción, 2025).

Previous studies highlight that sustainability of fishing resources, environmental management, and product quality are critical determinants of long-term competitiveness in the fisheries sector. Overfishing, bycatch, and environmental degradation negatively affect marine ecosystems and undermine export credibility, while deficiencies in post-capture handling and quality control increase rejection rates in international markets (Cámara & Santero-Sánchez, 2020; Gilman et al., 2021). While technological innovations such as selective fishing gear and monitoring systems offer significant potential to address these challenges, evidence suggests that technology adoption alone is insufficient unless supported by structured operational procedures, standardized work practices, and systematic performance measurement.

From an Industrial Engineering perspective, improving export competitiveness requires the translation of strategic sustainability and quality objectives into actionable, standardized, and measurable operational practices. However, existing studies tend to address sustainability, technology, and quality management in isolation, resulting in limited practical guidance for integrated operational implementation. This study addresses this gap by proposing a Standardized Operational Management Model (SOMM) that combines strategic diagnostics, standardized operational procedures, technological support, and key performance indicators to strengthen export competitiveness in the Peruvian fisheries sector.

### **1.1 Objectives**

- Identify the main factors affecting export competitiveness in the Peruvian fisheries sector.
- Prioritize these factors using strategic diagnostic tools.
- Propose a standardized operational management model integrating technology, procedures, and performance indicators to enhance export competitiveness.

## **2. Literature Review**

Export competitiveness in the fisheries industry has become increasingly linked to sustainability, consistency in product quality, and operational efficiency, especially within international markets that enforce stringent requirements related to traceability, environmental responsibility, and quality assurance (OECD & FAO, 2025). These conditions pose considerable challenges for fisheries sectors characterized by weak operational oversight, low levels of process standardization, and underdeveloped performance monitoring systems.

Within the Peruvian context, the fisheries sector holds a strategic position in the national economy, making a substantial contribution to employment creation and export revenues (Barturén et al., 2019). Despite its economic importance, the sector continues to face persistent difficulties, including variability in product quality, operational inefficiencies, limited access to international markets, and insufficient responsiveness to changing market demands (Ministerio de la Producción, 2020). Empirical comparisons between certified and non-certified firms reveal marked differences in management practices and operational discipline, underscoring the role of formal management systems, standardized processes, and quality assurance mechanisms in achieving sustainable competitive advantages (Barturén et al., 2019).

Sustainability is widely recognized as a fundamental driver of long-term competitiveness in fisheries. Environmental degradation, marine pollution, overexploitation of fish stocks, and high bycatch levels contribute to resource depletion and undermine the credibility and acceptance of fisheries products in global markets (Cámara & Santero-Sánchez, 2020; Gilman et al., 2021). Several studies indicate that the adoption of selective fishing technologies and improved gear design can substantially reduce environmental impacts while preserving productivity (Savina et al., 2022; Fujii et al., 2018). Nevertheless, shortcomings in environmental management and operational control remain underexplored in many fisheries systems, representing a significant opportunity for structured operational interventions (Tolentino & Zondervan, 2022).

From an operational and quality management standpoint, weaknesses throughout the fisheries value chain—from harvesting to processing and commercialization—continue to constrain export performance. Mpomwenda et al. (2022) emphasize the necessity of structured quality policies and standardized operational practices to ensure product consistency and compliance with international regulations. Likewise, Formentini et al. (2021) identify potential efficiency gains through modular and flexible operational frameworks capable of adapting to diverse market requirements. Hygiene standards, traceability systems, and quality control mechanisms have also been identified as critical factors for maintaining consumer trust and sustaining export competitiveness (Nuning et al., 2018).

Evidence from other industrial and agri-food sectors further supports the effectiveness of standardized operational frameworks in enhancing performance. Fin et al. (2017) report that the implementation of standardized work in a manufacturing setting resulted in notable improvements in productivity, process stability, and waste reduction through the formalization of operational procedures. Similarly, Realyvásquez-Vargas et al. (2019) document a case study in a small and medium-sized enterprise where process standardization reduced operational variability and improved efficiency, demonstrating the applicability of standardized approaches in resource-constrained environments.

Integrated improvement models that combine standardized work, performance measurement, and continuous improvement principles have also yielded positive outcomes in food-related operations. Hoces-Antesana and Guerrero-Villa (2024) show that the application of Lean Six Sigma tools, supported by standardized procedures and key performance indicators, significantly improved operational efficiency and reduced waste in essential food storage SMEs. In addition, Alarcón et al. (2024) provide empirical evidence from the chemical manufacturing sector, demonstrating that integrated Lean and Six Sigma frameworks can generate measurable gains in productivity, quality performance, and cost efficiency through systematic process control and KPI-based monitoring.

Technological innovation has been widely promoted as a means to address the challenges confronting the fisheries sector. Advances in fishing equipment, processing technologies, and monitoring systems offer considerable potential to enhance both efficiency and sustainability (Fatma, 2018; Fujii et al., 2018). However, recent studies suggest that technology adoption alone is insufficient to achieve sustained performance improvements unless it is supported by standardized operational procedures, workforce training, and continuous monitoring mechanisms (FAO, 2024).

Despite the expanding body of literature on sustainability, technology adoption, and quality management in fisheries, a significant gap remains in the development of integrated operational models that systematically combine diagnostic tools, standardized procedures, technological support, and performance measurement within a unified framework. Existing studies often address these elements independently, limiting their practical applicability for enhancing export competitiveness. This research addresses this gap by proposing an integrated Standardized Operational Management Model (SOMM) that translates strategic sustainability and competitiveness objectives into actionable, standardized, and measurable operational practices tailored to export-oriented fisheries operations.

### **3. Methods**

This research employs a qualitative and analytical methodology rooted in applied Industrial Engineering, with the objective of identifying structural constraints that affect competitiveness in the fisheries sector and transforming them into opportunities for operational improvement. A systematic review of secondary sources—including peer-reviewed academic journals, institutional publications, and sector-specific statistical reports released between 2020 and 2025—was conducted to identify recurrent challenges associated with sustainability, quality management, operational efficiency, and export performance.

The methodological design was organized into sequential stages. The first stage involved a strategic diagnostic assessment using recognized analytical tools to evaluate the external environment and prioritize key factors influencing competitiveness. Specifically, a PESTE analysis was employed to examine the political, economic, social, technological, and environmental dimensions of shaping fisheries export competitiveness. This approach facilitated a comprehensive understanding of the macro-environmental conditions impacting sector performance.

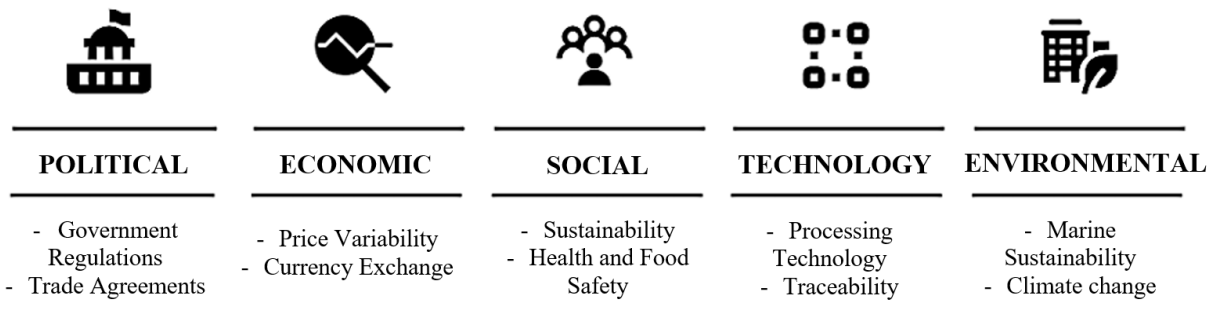


Figure 1. PESTE analysis of macro-environmental factors influencing export competitiveness in the Peruvian fisheries sector.

Figure 1 summarizes the results of the PESTE analysis, highlighting the main political, economic, social, technological, and environmental factors influencing the export competitiveness of the Peruvian fisheries sector. This analysis provides a structured overview of the external context in which fisheries operations and exports take place, serving as a diagnostic input for the subsequent prioritization of competitiveness factors using the IGO matrix.

In this study, the term “governance” is used to describe the degree of operational control and decision-making capacity that sector stakeholders have over each competitiveness factor. Governance reflects the extent to which factors can be influenced through managerial actions, standardized procedures, and operational interventions, rather than through external or regulatory changes. This definition is adopted to ensure clarity and consistency in the application of the Importance–Governance (IGO) matrix.

Second, the Importance–Governance (IGO) matrix was applied to rank the identified factors according to their level of influence on competitiveness and the extent to which they can be controlled by sector stakeholders. This prioritization process enabled the identification of high-impact factors that are realistically addressable through operational and managerial actions.

The results of the diagnostic stage served as the methodological foundation for the subsequent development of an operational management framework. Based on the prioritized factors, a Standardized Operational Management Model (SOMM) was conceptually designed, incorporating standardized operational practices, technological enablers, and performance measurement systems. The structure and components of this model are presented and discussed in the Results section.

#### **4. Data Collection**

Data collection was conducted exclusively through secondary sources to support both the diagnostic stage and the operational model design of the study. These sources included reports and statistical publications issued by international and national organizations such as the OECD, FAO, ICES, and the Peruvian Ministry of Production, in addition to peer-reviewed academic articles addressing fisheries management, sustainability, competitiveness, and operations management.

The information gathered encompassed sector performance metrics, sustainability assessments, policy frameworks, and empirical evidence from prior research. The consultation of multiple independent sources allowed for data triangulation, thereby strengthening the reliability and validity of the diagnostic analysis. To ensure the relevance and currency of the data, all referenced materials were published within the period from 2020 to 2025.

## 5. Results and Discussion

### 5.1 Numerical Results

The use of the Importance–Governance (IGO) matrix facilitated the prioritization of factors influencing competitiveness in fisheries exports. Both importance and governability were evaluated using a five-point Likert scale, where a value of 1 denotes a very low level and 5 represents a very high level. Importance refers to the extent to which each factor affects export competitiveness, whereas governability reflects the degree of control that sector stakeholders can exercise over each factor.

The findings show that the sustainability of fishing resources (F2) and the quality of fishery products (F3) achieved the highest combined scores in terms of importance and governability, identifying them as key priorities for operational intervention. These factors are closely associated with internal operational processes and can be effectively addressed through the implementation of standardized operating procedures, quality management systems, and performance monitoring mechanisms.

Conversely, factors such as the effects of climate change (F9) and international sanitary regulations (F1) display high levels of importance but low governability. This indicates that although these factors have a substantial impact on export competitiveness, they necessitate adaptive and mitigation strategies rather than direct operational control.

Table 1. Evaluation of export competitiveness factors based on importance and governance scores.

	<b>Factors</b>	<b>Importance</b>	<b>Governance</b>
F1	International Health Regulations	4	1
F2	Sustainability of Fishing Resources	5	5
F3	Quality of Fishery Products	5	5
F4	Port Infrastructure and Logistics	4	3
F5	Access to International Markets	4	5
F6	Technological Innovation in the Fishing Industry	4	3
F7	International Competition	4	2
F8	Price Fluctuation of Fishing Products	5	2
F9	Climate Change and Impact on Fishing	5	1
F10	Promotion of the "Peru" Brand in the International Market	2	4

Table 1 presents the evaluation of competitiveness factors based on their importance and governability scores. The results indicate that internal operational practices play a critical role in enhancing fisheries export competitiveness, thereby supporting the focus on operational management interventions proposed in this study.

### 5.2 Graphical Results

The outcomes of the PESTE and IGO analyses are visually integrated through the Importance–Governance (IGO) matrix, which provides a graphical representation of the prioritization of factors influencing fisheries export competitiveness. This matrix allows for the categorization of factors into four strategic quadrants according to their relative importance and degree of governability.

As illustrated in **Figure 2**, the sustainability of fishing resources and the quality of fishery products are located within the quadrant characterized by high importance and high governability. This positioning indicates that these factors have a significant impact on export competitiveness and can be effectively managed through internal operational and managerial measures. As such, they constitute appropriate focal areas for targeted improvement initiatives.

Conversely, factors including climate change effects and international regulatory demands are situated in the high-importance but low-governability quadrant, highlighting the need for adaptive and mitigation-oriented strategies rather than direct operational interventions. These visual findings reinforce the priorities identified in the quantitative analysis and are aligned with recent research on fisheries competitiveness and sustainability (OECD, 2025).

The graphical analysis provides a clear foundation for the subsequent development of the proposed Standardized Operational Management Model (SOMM), which is designed to address the most critical and governable factors through standardized operational practices, technological support, and performance measurement systems.

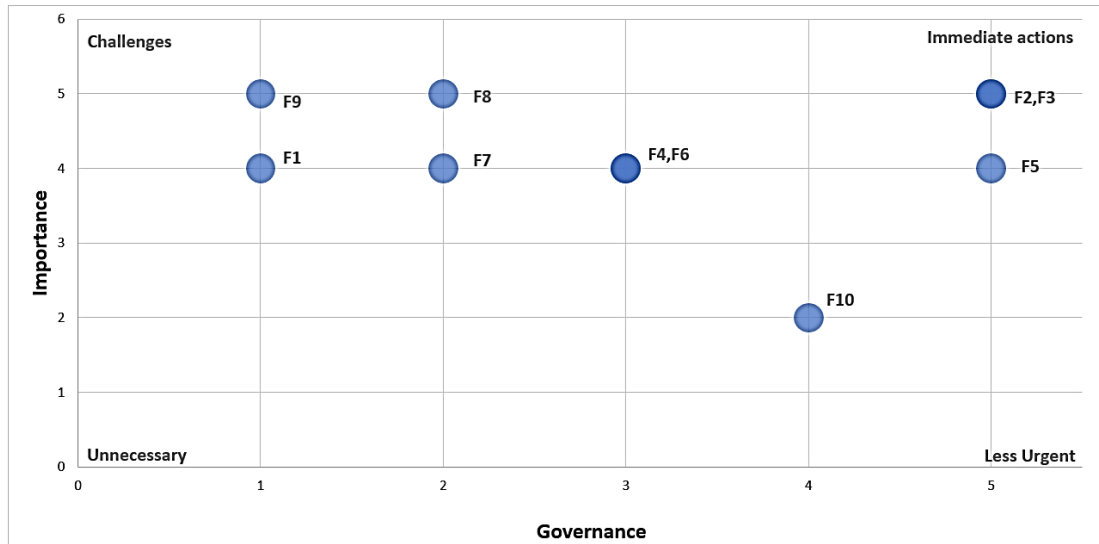


Figure 2. Importance–Governance (IGO) matrix showing the prioritization of factors affecting export competitiveness in the Peruvian fisheries sector.

### 5.3 Proposed Improvements

Based on the diagnostic results obtained from the PESTE and Importance–Governance (IGO) analyses, this study proposes a Standardized Operational Management Model (SOMM) aimed at improving fisheries export competitiveness through structured operational interventions. The model translates the prioritized competitiveness factors into standardized, measurable, and actionable operational practices aligned with sustainability, quality, and performance objectives.

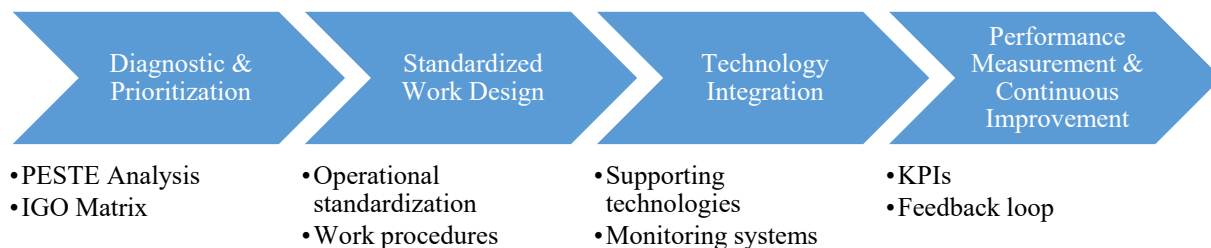


Figure 3. Standardized Operational Management Model (SOMM) for enhancing export competitiveness in the Peruvian fisheries sector.

**Figure 3** illustrates the conceptual framework of the SOMM, which consists of four interconnected components: operational diagnosis, standardized work development, technology–procedure integration, and performance measurement. These elements are structured to operate as a continuous management cycle, allowing for systematic operational oversight and fostering continuous improvement in fisheries operations.

The operational diagnosis component integrates the outcomes of the strategic and prioritization analyses and provides the basis for informed operational decision-making. The standardized work development component aims to minimize process variability and ensure consistency in key fishing and post-harvest activities. The integration of technology with procedures ensures that technological tools—such as monitoring and tracking systems—are embedded within and reinforce standardized operational practices rather than functioning independently. Lastly, the performance measurement component establishes a structured set of key performance indicators (KPIs) to track performance, assess compliance, and support timely corrective actions.

Table 2. Components of the Standardized Operational Management Model (SOMM), associated standardized procedures, and key performance indicators (KPIs)

<b>SOMM Component</b>	<b>Standardized Procedure</b>	<b>Description</b>	<b>KPI</b>
Standardized Work Design	Selective Fishing Operation	Definition of standardized fishing practices to target species	Catch Efficiency
Sustainability Control	Bycatch Monitoring	Measurement and control of incidental catch	Bycatch Rate (%)
Quality Management	Post-Capture Quality Control	Handling and storage procedures to ensure export quality	Export Rejection Rate (%)
Technology Integration	Monitoring Systems	Use of technology to track operations	Compliance rate (%)
Performance Measurement	KPI Review Process	Periodic evaluation of operational performance	Performance index

**Table 2** outlines the operationalization of the SOMM by associating each model component with standardized procedures, defined operational scopes, and their corresponding key performance indicators (KPIs). The proposed procedures encompass selective fishing activities, bycatch monitoring, post-harvest quality control, technology-enabled monitoring systems, and periodic performance review processes. These procedures are specifically designed to address the high-priority and high-governability factors identified through the IGO matrix, thereby ensuring consistency between the diagnostic findings and the proposed operational interventions.

Table 3. Definition and measurement frequency of key performance indicators (KPIs).

<b>KPI</b>	<b>Definition</b>	<b>Measurement Frequency</b>
Catch Efficiency	Ratio of target species captured to fishing effort	Per fishing trip
Bycatch Rate (%)	Incidental catch relative to total catch	Per fishing trip
Export Rejection Rate (%)	Rejected export shipments due to quality issues	Monthly
Compliance rate (%)	Degree of adherence to standardized procedures	Monthly
Performance index	Percentage of operators trained and certified	Quarterly

**Table 3** reinforces the operational framework by specifying the selected KPIs and their respective measurement frequencies. The proposed indicators facilitate the monitoring of sustainability outcomes, such as bycatch rates; productivity levels, including catch efficiency; quality performance, reflected in export rejection rates; adherence to standardized procedures; and the development of workforce capabilities. Collectively, the figure and tables present a coherent and practical framework that supports informed decision-making, accountability, and continuous improvement within the fisheries sector.

The proposed SOMM is aligned with empirical evidence documented in comparable industrial and agri-food settings, where standardized operational frameworks supported by performance indicators have produced measurable gains in

productivity, quality consistency, and operational control. Case studies in manufacturing and small and medium-sized enterprise contexts indicate that the adoption of standardized procedures contributes to reduced operational variability and improved process stability (Fin et al., 2017; Realyvásquez-Vargas et al., 2019). Likewise, integrated improvement models that combine standardized work, performance metrics, and continuous improvement principles have been successfully implemented in food-related operations, leading to enhanced efficiency and waste reduction (Hoces-Antesana & Guerrero-Villa, 2024; Alarcón et al., 2024). This body of empirical evidence supports the practical applicability of the SOMM as an effective mechanism for translating sustainability and competitiveness goals into structured operational practices within the fisheries sector.

By integrating standardized operational practices, technological support, and KPI-based performance measurement, the SOMM provides a practical Industrial Engineering-oriented approach to strengthening fisheries export competitiveness while addressing the sustainability and quality challenges identified during the diagnostic phase.

#### **5.4 Validation**

Although this study did not include empirical validation through direct field implementation, the proposed Standardized Operational Management Model (SOMM) was conceptually validated using multiple complementary criteria commonly adopted in applied Industrial Engineering research.

First, the internal coherence of the model was assessed by verifying the logical alignment between the diagnostic outcomes derived from the PESTE analysis and the prioritization results obtained through the Importance-Governance (IGO) matrix, and the operational components proposed in the SOMM. Each element of the model directly responds to high-priority and high-governance factors identified during the diagnostic stage, particularly those related to the sustainability of fishing resources and the quality of fishery products, which were identified as the main drivers of export competitiveness.

Second, the conceptual soundness and practical relevance of the SOMM are reinforced by its strong consistency with empirical evidence reported in comparable industrial and agri-food contexts. Previous implementation-based studies demonstrate that standardized operational frameworks integrating formal procedures, performance indicators, and continuous improvement mechanisms generate measurable improvements in productivity, quality consistency, and operational control (Fin et al., 2017; Realyvásquez-Vargas et al., 2019). More recent research further confirms that integrated models combining standardized work, KPI-based monitoring, and improvement methodologies such as Lean Six Sigma achieve significant efficiency gains and waste reduction in food-related and process-intensive operations (Hoces-Antesana & Guerrero-Villa, 2024; Alarcón et al., 2024). This body of empirical evidence supports the feasibility of adapting similar principles to fisheries operations through the proposed SOMM.

Third, the SOMM is aligned with established Industrial Engineering principles related to process standardization, operational control, and performance measurement. The proposed KPI system enables systematic monitoring of sustainability, quality, productivity, and compliance, thereby supporting evidence-based decision-making and continuous improvement. Furthermore, the integration of technological tools within standardized procedures strengthens operational discipline and reduces execution variability, particularly in contexts characterized by heterogeneous operating conditions.

To facilitate future empirical validation, a concrete pilot study design is proposed. The SOMM could be implemented on a pilot basis within a medium-sized, export-oriented fisheries operation over a six- to twelve-month period. Baseline operational data would be collected prior to implementation, followed by periodic measurement of key performance indicators such as catch efficiency, bycatch rate, export rejection rate, and compliance with standardized procedures. Comparative analysis between pre- and post-implementation performance would allow for a quantitative assessment of the model's impact on operational performance and export competitiveness.

Finally, potential implementation barriers within the Peruvian context should be acknowledged. These include variability in fleet size and technological maturity, limited access to real-time monitoring systems among small-scale operators, workforce training constraints, and possible resistance to process standardization. Nevertheless, the modular and scalable structure of the SOMM allows for gradual adoption using existing industry practices and available technologies. Addressing these barriers through phased implementation strategies and targeted capacity-building initiatives represents an important direction for future research.

## 6. Conclusion

This research demonstrates that export competitiveness in the Peruvian fisheries sector can be enhanced through structured operational management approaches grounded in Industrial Engineering principles. By integrating strategic diagnostic tools—specifically the PESTE analysis and the Importance–Governance (IGO) matrix—with an applied operational framework, the study identifies the sustainability of fishing resources and product quality as the most critical and controllable determinants of export competitiveness.

The proposed Standardized Operational Management Model (SOMM) consolidates standardized operating procedures, selective fishing technologies, and KPI-based performance measurement within a coherent and operationally viable framework. In contrast to approaches that prioritize technological adoption or regulatory measures in isolation, the SOMM highlights process standardization, operational discipline, and performance monitoring as key mechanisms for achieving consistent sustainability and quality outcomes in export-oriented fisheries operations.

All research objectives were fulfilled, and this study contributes to existing literature by offering a practical, structured, and replicable Industrial Engineering–based model that effectively connects strategic diagnosis with operational implementation. The modular and scalable design of the SOMM indicates its potential applicability beyond the Peruvian context, extending to other fisheries subsectors and export-oriented food industries facing comparable competitiveness challenges. Future research should focus on empirical validation through pilot applications and on quantitatively evaluating the impact and scalability of the model across diverse fisheries contexts.

## References

- Komugabe-Dixon, A.F., Bucio Bustos, E., Canio, A., Chacon, C., Claudino, R., De Lemos, N., Dixon, H.G.W., Joo, R., Luck, C., Matthews, K., Mejaes, A., Espinoza-Miralles, M., and Heenan, A., “Capacity development for technology adoption in fisheries and conservation requires two-way learning,” *ICES Journal of Marine Science*, 82(10), fsaf142, 2025. <https://doi.org/10.1093/icesjms/fsaf142>
- Alarcón, F.J., Calero, M., Martín-Lara, M.Á., and Pérez-Huertas, S., “An Integrated Lean and Six Sigma Framework for Improving Productivity Performance: A Case Study in a Spanish Chemicals Manufacturer,” *Applied Sciences*, 14(23), p. 10894, 2024. <https://doi.org/10.3390/app142310894>
- Azra, M.N., Okomoda, V.T., and Ikhwanuddin, M., “Breeding technology as a tool for sustainable aquaculture production and ecosystem services,” *Frontiers in Marine Science*, 9, 2022. <https://doi.org/10.3389/fmars.2022.679529>
- Barturén Villanueva, O.B., Figueroa Asencios, F.O., Tábora Ortiz, M.N., and Tamayo Quispe, P.M., *Calidad en las empresas peruanas del sector pesquero*, Pontificia Universidad Católica del Perú, 2019. <https://tesis.pucp.edu.pe/repositorio/handle/20.500.12404/14869>
- Cámara, A., and Santero-Sánchez, R., “Economic, social, and environmental impact of a sustainable fisheries model in Spain,” *Sustainability*, 11(22), p. 6311, 2019. <https://doi.org/10.3390/su11226311>
- Chuenban, P., Sornsaruht, P., and Pimdee, P., “How brand attitude, brand quality, and brand value affect Thai canned tuna consumer brand loyalty,” *Heliyon*, 7(2), e06301, 2021. <https://doi.org/10.1016/j.heliyon.2021.e06301>
- Cortés, A., Esteve-Llorens, X., González-García, S., Moreira, M.T., and Feijoo, G., “Multi-product strategy to enhance the environmental profile of the canning industry towards circular economy,” *Science of the Total Environment*, 791, p. 148249, 2021. <https://doi.org/10.1016/j.scitotenv.2021.148249>
- FAO, *Report of the Working Group on Fishing Technology (WGFIT)*, Food and Agriculture Organization of the United Nations, Rome, 2024. <https://www.fao.org/gfcm/technical-meetings/detail/en/c/1682935/>
- Fatma, E., “Development of sustainable tuna processing industry using system dynamics simulation,” *Procedia Manufacturing*, 2015. <https://doi.org/10.1016/j.promfg.2015.11.020>
- Figueroa, J.J.R., “Diseño prospectivo de escenarios para la ciencia, tecnología e innovación al 2040,” *Industrial Data*, 16(2), pp. 92–105, 2013.
- Fin, J., Vidor, G., Cecconello, I., and de Campos Machado, V., “Improvement based on standardized work: an implementation case study,” *Brazilian Journal of Operations & Production Management*, 2017. <https://doi.org/10.14488/BJOPM.2017.v14.n3.a12>
- Formentini, G., Favi, C., Moroni, F., and Pironi, A., “Engineering design in food packaging industry: The case study of a tuna canning machine,” *Procedia CIRP*, 100, pp. 229–234, 2021. <https://doi.org/10.1016/j.procir.2021.05.060>

- Fujii, H., Sakakura, Y., Hagiwara, A., Bostock, J., Soyano, K., and Matsushita, Y., "Research and development strategy for fishery technology innovation for sustainable fishery resource management in North-East Asia," *Sustainability*, 10(1), p. 59, 2017. <https://doi.org/10.3390/su10010059>
- Gilman, E., Chaloupka, M., and Sieben, C., "Ecological risks of a data-limited fishery using an ensemble of approaches," *Marine Policy*, 133, p. 104775, 2021. <https://doi.org/10.1016/j.marpol.2021.104775>
- He, Y., Huang, S., and Tang, Y., "Sustainable practicalities towards good governance in fish townships and villages by ethics-based approach," *Sustainability*, 14(12), p. 7505, 2022. <https://doi.org/10.3390/su14127505>
- Hoces, H., *Informe final del proyecto: Mejoramiento de la productividad y competitividad de la cadena productiva de la pesca y acuicultura en la región Tumbes*, Universidad Nacional Agraria de la Selva, 2009.
- Hoces-Antesana, K., and Guerrero-Villa, C., "Implementing Lean Six Sigma to Enhance Operational Efficiency and Reduce Waste in Essential Food Storage SMEs: A Case Study," *1st World Congress 2024 Detroit*, 2024. <https://doi.org/10.46254/wc01.20240026>
- ICES, *ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB)*, ICES Scientific Reports, 2025. <https://doi.org/10.17895/ices.pub.30231325.v1>
- Jiménez Veloza, A.F., and Guerra Zambrano, D.Y., "Análisis de las variables de productividad y competitividad del sector pesquero en Lima y Bogotá," 2021.
- Kleeberg, R., Olivera, N.L., Cisneros-Montemayor, A.M., and Sumaila, U.R., "La pesca en el Peru: historia, evolución y estado actual," *Memorias de la Conferencia Internacional del Consorcio de Universidades*, p. 20, 2013.
- Ministerio de la Producción, *Estadística Pesquera*, 2022.
- Ministerio de la Producción, "Exportaciones del sector pesquero crecieron 54.1 % en los primeros cinco meses del 2025," Gobierno del Peru, 2025.
- Mpomwenda, V., Tómasson, T., Pétursson, J.G., Taabu-Munyaho, A., Nakiyende, H., and Kristófersson, D.M., "Adaptation strategies to a changing resource base: Case of the gillnet Nile perch fishery on Lake Victoria," *Sustainability*, 14(4), p. 2376, 2022.
- Nguyen, T.V., Simioni, M., Quyen, C.L., and Valtýsson, H.P., "Productivity, technical efficiency, and technological change in Vietnamese oceanic tuna fisheries," *Fisheries Research*, 248, 2022. <https://doi.org/10.1016/j.fishres.2021.106202>
- Nuning, R.W., "Development of Tuna Processed Business in Pacitan District, Indonesia," 2018. <https://doi.org/10.1016/j.aqpro.2016.07.022>
- OECD, *OECD Review of Fisheries 2025*, OECD Publishing, 2025. <https://doi.org/10.1787/560cd8fc-en>
- Peña Pinto, N.D., and Pecho Pecho, E.G., "La gestión de la cadena de suministro de la exportación de pota congelada al mercado de China en los años 2016–2020," 2020.
- Realyvásquez-Vargas, A., Flor-Moltalvo, F.J., Blanco-Fernández, J., Sandoval-Quintanilla, J.D., Jiménez-Macías, E., and García-Alcaraz, J.L., "Implementation of Production Process Standardization—A Case Study of a Publishing Company from the SMEs Sector," *Processes*, 7(10), p. 646, 2019. <https://doi.org/10.3390/pr7100646>
- Savina, E., Veiga-Malta, T., Melli, V., Sokolova, M., Machado, L.S., and Feekings, J., "Fishers can optimize gear design if the management system allows flexibility," *Ocean & Coastal Management*, 227, p. 106286, 2022. <https://doi.org/10.1016/j.ocecoaman.2022.106286>
- Sociedad Nacional de Pesquería, *Reporte de Sostenibilidad*, 2022.
- Tolentino-Zondervan, F., and Zondervan, N., "Sustainable fishery management trends in Philippine fisheries," *Ocean & Coastal Management*, 2022. <https://doi.org/10.1016/j.ocecoaman.2022.106149>
- White, E.R., Baker-Médard, M., Vakhitova, V., Farquhar, S., and Ramaharitra, T.T., "Distant water industrial fishing in developing countries: A case study of Madagascar," *Ocean & Coastal Management*, 216, p. 105925, 2022. <https://doi.org/10.1016/j.ocecoaman.2021.105925>
- Zhao, X., and Jia, P., "Towards sustainable small-scale fisheries in China: A case study of Hainan," *Marine Policy*, 2020. <https://doi.org/10.1016/j.marpol.2020.103935>

## Biographies

**José Gianpierre Ramirez Toro** has a degree in Industrial Engineering from the University of Lima in Peru. He is interested in process improvement, increased productivity, and knowledge of Lean methodologies. He belongs to the raw materials purchasing team at the leading mass consumption company in Peru.

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**Richard Nicolás Meza Ortiz** has a degree in Industrial Engineering from the University of Lima. He specialized in logistics and operations of materials and the supply chain from ESAN University and completed an MBA in business administration and management from CENTRUM PUCP. He is a senior executive with more than 15 years of experience leading supply chain management in transnational companies. With experience in operations planning, purchasing, foreign trade, warehouse management, projects, marketing of by-products, results-oriented, leading multidisciplinary teams, and promoting continuous process improvement.