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ANALYSIS OF THE IMPLEMENTATION OF A TRACEABILITY SYSTEM FOR VARIOUS FISHERY PRODUCTS AT PT BEEJAY SEAFOOD

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ABSTRACT

Processing various fishery commodities within a single production system increases the complexity of product information management and the risk of record-keeping discrepancies, which can affect the effectiveness of the traceability system and compliance with export market requirements. This study aims to analyze the implementation of a traceability system in the processing of frozen fishery products at PT Beejay Seafood. The study was conducted from September to November 2025 using a descriptive method, with data collected through field observations, interviews, and documentation. Data analysis mapped the production process flow, identified internal and external traceability recording points, and determined their relationship to Critical Control Points (CCPs) based on observations, interviews, and documentation. The results showed that the internal traceability system was implemented through name tags, recording forms, production codes, and interconnected barcodes from raw material receipt through distribution of the final product. Process variations were found in the raw material receipt and primary processing stages based on commodity characteristics, while the cooling and freezing stages showed relatively similar handling patterns. CCPs are applied during the raw material reception stage and metal detector inspections as part of quality control and food safety measures. External traceability is conducted by recording supplier identities and tracking product distribution using production codes and barcodes. However, the traceback system currently in place remains reactive, triggered by customer complaints and is not yet digitally integrated with external parties. This study indicates that the implementation of traceability systems in the seafood processing industry is influenced by commodity characteristics, process risks, and quality control mechanisms at each stage of production.

Keywords: Barcode; CCP; Food Safety; Fishery Product Processing; Traceability System.

INTRODUCTION

The fisheries processing industry still faces challenges in maintaining product quality and safety throughout the supply chain. Post-harvest losses of fishery products in Indonesia are estimated to reach around 30% (FAO, 2015; PDSPKP, 2023; Poernomo & Poernomo, 2020). These high levels of post-harvest losses not only result in economic losses but also highlight the importance of identifying the location, timing, and causes of quality degradation during handling, processing, and distribution. These conditions underscore that managing product information through a traceability system is critical to ensuring that every stage of the supply chain can be accurately traced so quality deviations can be quickly identified and addressed.

The traceability system allows each product to be tracked throughout the supply chain via two main functions: trace back, which tracks the origin of raw materials back to the producer or fisher, and trace up, which tracks the movement of products through the distribution chain to the consumer(Karlsen *et al*., 2013). These capabilities help identify the source of quality nonconformities, expedite traceback in the event of food safety issues, and enhance transparency and accountability in the management of fishery products. Integrating traceability systems with supply chain management also supports effective quality control based on Hazard Analysis and Critical Control Point (HACCP) principles, improves production management efficiency by recording each process stage, and strengthens market confidence in traded fishery products. Implementing a traceability system is not only necessary to meet regulatory requirements but also serves as a managerial tool that supports the competitiveness of the fishery products processing industry in the global market (Bosona & Gebresenbet, 2013; KKP, 2025).

PT Beejay Seafood is a seafood processing company based in Probolinggo that produces frozen fish and fillets for domestic and export markets. The company is committed to providing seafood products that meet international quality standards by implementing GMP, SSOP, and HACCP, as well as developing value-added processed products to support market expansion. In its operations, the company handles various seafood commodities with different raw material characteristics and process flows. These conditions increase the complexity of information control because each commodity requires different handling and recording mechanisms. According to Hopkins *et al*. (2024), the more complex the supply chain and the greater the number of nodes in distribution and processing, the more difficult it becomes to implement comprehensive traceability. The diversity of commodities and process stages can increase the risk of record-keeping discrepancies, product lot mix-ups, and disruptions in information flow if not supported by a robust traceability system.

Several studies indicate that the implementation of a traceability system in the fishery products processing industry plays a crucial role in maintaining food quality and safety, particularly for export products. Traceability systems are implemented through internal and external record-keeping

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linked to production processes, quality control, and product distribution (Hasibuan *et al*., 2021; J. Sirait, 2024; Siregar *et al*., 2024). However, various studies also indicate that the implementation of traceability systems in the fisheries industry still faces several challenges, such as the use of paper-based systems, limited data digitization, inconsistent application of GMP/SSOP, and the lack of a dedicated traceability team (J. Sirait, 2024; Masengi *et al*., 2018). In addition, obstacles to meeting international standards, such as Chain of Custody requirements and sustainability certification, are still found in the Indonesian fisheries industry (Fuah *et al*., 2023). These findings indicate that the implementation of traceability systems in the fish processing industry still requires strengthening, particularly in the integration of record-keeping, quality control, and information management across production stages.

A research gap exists due to the limited number of studies examining the operational implementation of a traceability system at a single fishery processing facility that handles multiple commodities with different characteristics and quality risks, such as demersal fish (goldband snapper), pelagic fish (narrow-barred Spanish mackerel), and vannamei shrimp. The differences in the characteristics of these raw materials result in variations in production process stages, *critical* control points (CCPs), and information recording requirements for each commodity, thereby making the implementation of traceability systems more complex. Most previous studies have focused on a single commodity or discussed traceability in a normative manner without detailing recording mechanisms or the integration of manual and digital systems in industrial practice. Furthermore, prior research has not extensively addressed the relationship between variations in production processes, CCPs, and the continuity of information within traceability systems in the multi-commodity processing industry. Therefore, a study is needed that can operationally describe the implementation of traceability systems by tracing production process flows, critical control points (CCPs), and record-keeping practices across various commodities within a single processing unit. Consequently, this study aims to analyze the relationship between production process flows, CCPs, and recording mechanisms in implementing traceability systems for various fishery commodities at PT Beejay Seafood. In this study, commodity differences are not treated as the primary variable but as an operational context that influences variations in process flows and quality control points.

RESEARCH METHODOLOGY

Research Location and Time

This study uses a qualitative descriptive approach to analyze the implementation of a traceability system in processing frozen fishery products at PT Beejay Seafood. The study was conducted from September to November 2025 at PT Beejay Seafood in Probolinggo, with the research subjects including the production process flow, the implementation of Critical Control Points (CCPs), and the internal and external traceability recording systems for mackerel, anggoli fish, and shrimp.

Selection of Research Informants

Researchers selected informants using purposive sampling, intentionally choosing them based on their involvement in and understanding of the company's traceability system. Informants included production staff, Quality Control (QC) staff, raw material receiving staff, information technology (IT) staff, distribution staff, the operations manager, the QC manager, and the company director.

Data Collection Techniques

Data collection was conducted through observation, interviews, and documentation. Observations were conducted by following the production processes for each commodity to identify production workflows, CCP implementation, and traceability system recording points. Semi-structured interviews were conducted with research informants to obtain information regarding the mechanisms for implementing the traceability system, quality control, and recording procedures at each stage of production. Documentation was carried out by collecting various company documents related to the traceability system.

Data Validation and Validity

The analyzed documentation included receiving forms, supplier data, supplier HACCP documents, CCP monitoring forms, metal detector inspection forms, laboratory test results, HACCP certificates, name tags, barcode labels, production logs, packing labels, cold storage records, Health Certificates (HC), and product distribution forms. The data were analyzed descriptively and analytically by mapping the production process flow, identifying traceability recording points, and linking them to CCPs for each commodity.

Data Analysis

Data analysis followed the Miles and Huberman model, which includes data reduction, data presentation, and conclusion. During the data reduction stage, findings from observations, interviews, and documentation were selected and grouped based on the research focus: the production process flow, the implementation of Critical Control Points (CCPs), and internal and external traceability systems. Information not related to the research focus is not carried forward to the analysis stage. The reduced data is then presented as descriptive narratives, tables, and process flowcharts to facilitate the identification of relationships between production stages, recording points, and CCPs. The final stage involves drawing conclusions based on the patterns and relationships identified during the analysis process.

RESULTS AND DISCUSSION

Variations in Production Process Flows Across Commodities

To illustrate variations in production process flows at PT Beejay, Table 1 compares key processing stages for mackerel, anggoli fish, and shrimp. This table highlights differences in treatment at several major stages, while other stages are implemented relatively uniformly.

Raw materials must be handled quickly and carefully during the receiving process in accordance with SNI 4110-2020, which requires that raw materials received at the processing unit undergo organoleptic testing to determine their quality.. This SNI standard ensures that products are free from contamination, meet microbiological limits, and have a core temperature of (-18) *°C* or lower (BSN, 2020). During the raw material receiving stage, all fishery commodities processed at PT Beejay Seafood first undergo organoleptic testing with an acceptance score of 7–9 as a basic quality requirement. This test serves as an initial screening to ensure that the received raw materials are still in a condition suitable for processing. However, in addition to this organoleptic test, each commodity undergoes additional treatments based on its characteristics and susceptibility to quality deterioration.

Table 1. Production Process Flow for the Three Commodities

Process Stage	Mackerel (Pelagic)	Anggoli (Demersal)	Shrimp
Raw material receipt (CCP)	Fresh; temperature ≤4°C, organoleptic, histamine ≤50 ppm	Frozen; temperature ≤−18°C, organoleptic	Fresh; temperature ≤4°C, organoleptic
Primary processing			
Sorting	-	Performed	-
Filleting	Performed	Performed	-
Remove Bones	Performed	Performed	-
Deheading			Performed
Shelling/Peeling			Performed
Yield Weighing	Uniform	Uniform	Uniform
Portioning and Sizing	Uniform	Uniform	Uniform
Packaging and Vacuuming (CCP)	Uniform	Uniform	Uniform
Refrigeration & Freezing	Uniform	Uniform	Uniform
Packaging & Metal Detector (CCP)	Uniform	Uniform	Uniform
CS Storage & Distribution	Uniform	Uniform	Uniform

Mackerel, as a group of pelagic fish, is accepted in fresh condition and undergoes additional quality screening in the form of histamine or fat content testing in accordance with the buyer's recommendation of ≤50 ppm, given its susceptibility to relatively rapid quality deterioration. This approach reflects the high quality risk associated with pelagic fish, which requires stricter controls during the raw material acceptance stage. In contrast, anggoli fish, which belong to the demersal fish group, are accepted in frozen condition. Using frozen raw materials provides greater quality stability and flexibility in managerial handling, while still meeting the company's quality standards..

Meanwhile, suppliers deliver shrimp fresh. During receiving, the shrimp undergo size sorting and physical and organoleptic quality inspections to ensure compliance with the company's quality standards. If the raw materials do not meet the established quality standards, the company implements a mechanism for returning the raw materials to the supplier. Quality control at the receiving stage is crucial because shrimp are a commodity prone to quality deterioration from physical damage, enzymatic activity, and microbial growth during postharvest handling and cold storage (Ahmad et al., 2025).

Variations among commodities are also evident in the primary processing steps. Mackerel do not undergo scaling and proceed directly to filleting and trimming after initial weighing. In contrast, anggoli fish require a scaling process before filleting, as an adaptation to the physical characteristics of this demersal fish. Differences in habitat and physical characteristics between pelagic and demersal fish result in variations in the main processing stages, where demersal fish require scaling before filleting. In contrast, pelagic fish can be processed directly without that stage (Friedman *et* al., 2020). For shrimp, the main processing steps include head removal (deheading) and shell peeling before further processing. These steps constitute specialized handling that distinguishes shrimp from other commodities such as fish fillets, as shrimp have a complex body structure and the head and shell must be removed to meet product quality standards (Lestari *et al*., 2022).

Although there are variations in the raw material reception and primary processing stages, the cooling and freezing stages for all three commodities follow relatively similar handling patterns. These similarities indicate that differences in technical treatment among commodities do not alter the basic structure of the overall production flow; rather, they reflect operational adjustments designed to manage quality risks in line with each commodity's characteristics.

Overall, variations in production processes among commodities at PT Beejay Seafood stem not from differences in the production flow structure, but from the technical treatments and quality control strategies applied at specific stages. These variations form an important basis for understanding the differences in critical quality control points and traceability documentation requirements for each commodity, which will be discussed further in the following subsection.

Critical Control Points (CCPs) and Traceability System Documentation Requirements

Identifying CCPs serves not only as a quality control measure but also as a critical data node in the traceability system, acting as a key recording point (Regiana *et al*., 2023). In this context, CCPs are process points that require more detailed documentation because they pose significant quality and safety risks and directly impact product traceability. Based on the variations in the CCP process flow established by PT Beejay, the following applies:

1. The first CCP is located at the raw material receiving stage. For all processed fishery commodities, this stage begins with an organoleptic test as a basic quality requirement under SNI 4110-2020, with an acceptance score of 7–9. Recording the organoleptic test results is a crucial element of internal traceability documentation, as it provides evidence of the raw materials' suitability before they enter the processing stage. Specifically for mackerel, which belongs to the pelagic fish group, histamine testing is conducted as an additional control measure. Including this histamine test designates the raw material acceptance stage as a Critical Control Point (CCP) requiring more detailed record-keeping, given the high risk of histamine formation and its implications for food safety. Raw material temperature checks ensure the core temperature of fresh fish remains low: ≤4 *°C* (shrimp and mackerel) and ≤-18 *°C* (Angooli) to maintain product quality and safety by inhibiting microbial activity, enzymatic reactions, and lipid oxidation during storage (Nento, 2015) . The cold chain principle applied during the handling of fish raw materials preserves quality by inhibiting the activity and growth of spoilage microorganisms (Siregar *et al*., 2024). hus, the

CCP at the raw material reception stage directly enhances traceability documentation by recording commodity-specific quality test results.

2. The second CCP is located at the product labelling stage. The labelling stage at PT Beejay Seafood serves two main functions. First, as a CCP in the HACCP system through the verification of allergen labels (May Contain Fish) to ensure that the allergen information on the packaging matches the product's characteristics, thereby preventing risks to consumers with allergies. Second, the system supports traceability through production codes, barcodes, and lot identifiers, which allow products to be traced throughout the supply chain.
3. The third CCP is the metal detector inspection stage, which is uniformly applied to all commodities. This stage serves as a final control against potential physical hazards before products are stored and distributed. During the metal detector inspection stage, the equipment sensitivity is verified using test pieces made of Fe, Non-Fe, and stainless steel as part of validating physical hazard controls within the HACCP system. In the food industry, commonly used detection sensitivities range from 1.5–2.0 mm for iron, 2.0–2.5 mm for non-ferrous metals, and 2.5–3.0 mm for stainless steel, depending on the product type and equipment specifications (Murti, 2022). Recording the results of metal detector inspections is a crucial part of traceability documentation because it serves as final evidence that the product meets food safety requirements. This CCP strengthens traceability by providing a record of critical controls at the downstream stage of the production process.

Overall, implementing CCPs at PT Beejay Seafood focuses not only on quality control but also on the structure and depth of record-keeping within the traceability system. Each CCP requires additional documentation that strengthens product traceability from raw materials to the final product, so the traceability system not only records process flow but also documents the critical controls at strategic stages of production.

Traceability System at PT Beejay

Traceability in fishery product processing includes both internal and external traceability. Internal traceability covers all inputs and processes involved in fish handling and/or processing activities. In contrast, external traceability encompasses the ability to identify the origin of raw materials and the marketing or distribution destinations of the products (National Fish Traceability and Logistics System, 2021) . The traceability system implemented at PT Beejay Seafood is supported by internal and external record-keeping conducted at every stage of the production process through a combination of manual, form-based record-keeping and data entry into a digital tabulation system at specific stages. This record-keeping aims to maintain the traceability of the product flow from the receipt of raw materials to the distribution stage, with the level of detail tailored to the quality risks at each stage of the process.

Based on Table 2, PT Beejay Seafood uses two complementary recording systems to support traceability: a manual, document-based (paper-based) system and the company's internal digital system. The paper-based system generally functions as a tool for operational control and compliance with quality standards by recording process conditions, while the digital system supports product identification, data integration, and more systematic tracking of product flow throughout the supply chain (Regiana *et al*., 2023). PT Beejay implements the paper-based system in processing stages related to environmental condition control and process quality, such as scaling, filleting, deboning, deheading, peeling, cooling, freezing, and metal detector inspections, with recorded information including temperature data, inspection results, and quality control checklists as a form of operational oversight in the production area. Meanwhile, the company's internal digital system is implemented at key points related to product identification and product flow, such as during raw material receipt, yield weighing, portioning and sizing, and storage and distribution in cold storage.

Table 2. Recording Points and Systems in the Production Process

Process	Identification & Documentation Media	Information	System
Raw Material Receipt	Raw material receipt form, name tag, and tally sheet	Organoleptic test results, supplier name, type, and weight of fish	Name tag 1 and entry into the local system
Primary Processing	Temperature monitoring	Temperature details	Paper-Based
Yield Weighing	Yield Calculation Form and Tally Sheet	Weight and yield percentage	Input to the local system
Portioning and Sizing	Product recording form, name tag, and tally sheet	Fish species, vessel name, production date, product type, and size	Name tags 2 and 3, and input into the local system
Packaging & Vacuuming	Packaging results form	Product quantity and type	Paper-based
Cooling & Freezing	Temperature Monitoring Form	Periodic Temperature Details	Paper-based
Packaging and Metal Detector	Labeling Form and Metal Detector Form	Verification of Name Tags 2 & 3, Metal Detector Checklist	Paper-based
Cold Storage and Distribution	Checker Form, Tally In and Tally Out	Checker results, product type, production date, and quantity	Paper-based, barcode scanning, and data entry into SIM B,

Internal Traceability

During the raw material receipt stage, record-keeping serves as the foundation of the traceability system. The information recorded includes the supplier's name, commodity type, receipt date, and quality test results. Post-production information can be identified via the name t*ag* shown in Figure 1.

Muji	11/08/25
AG (anggoli) UK 100 up	

Figure 1. Name tag 1

The information based on the name tag is recorded along with the raw material receipt form and tally sheet, then entered into the company's local system. Recording at this stage serves as the primary foundation for internal traceability, as all subsequent process information will refer to the initial identity listed on Name Tag 1. Before entering the processing stage, the raw materials are reweighed to determine their actual weight after melting and processing. This weighing is not intended to alter the raw material receipt data but rather to add information on the initial process weight as part of internal controls. All additional information remains attached to Name Tag 1, ensuring the raw material's supplier identity is maintained without interruption, even if weight adjustments occur due to the frozen state of the raw materials.

During the main processing stage, the identity of the raw materials is maintained through the continued use of name tag 1, which is attached to the fish baskets or containers throughout the process. Record-keeping at this stage focuses on controlling process conditions using paper-based daily temperature check forms, without adding new product identifiers. Thus, internal traceability is maintained through a link to the initial identity of the raw materials. This information is reinforced during the yield weighing stage, where the weight of the processed product and the yield percentage are recorded and partially entered into the company's local system. This stage serves as the quantitative link between the raw materials and the processed products within the batch-based internal traceability system.

Next, during the portioning and sizing stages, the internal traceability system is reinforced with additional name tags (name tag 2 and name tag 3). At this stage, the name tags include more specific product information, such as the type of fish, the vessel's name, the production date, the product type, and the product size. This information is recorded alongside the product recording form and tally sheet, then entered into the company's local system, as shown in the name tag example in Figure 2.

AG SKO
5/8

AG → Anggoli
SKO → Skin On
5/8 → Product UK

280/25/LB/29/08/25/2

280/25 → Raw Material Receipt Date
LB → Ship Name
29/08/25/2 → Production Date and Production Batch

Figure 2. Name Tag 2 & Name Tag 3

Assigning name tags 2 and 3 marks the transition from the raw material's identity to that of the intermediate and finished products, allowing more detailed internal traceability by production batch. During packaging, cooling, and freezing, record-keeping focuses on process and quality control. The recording media used consist of packaging result forms and temperature monitoring forms, which are completed periodically. The information recorded includes the quantity and type of products, as well as temperature conditions during cooling and freezing, with name tags 2 and 3 remaining attached throughout.

The packing and metal detector inspection stages serve as the final verification points in the internal traceability system before products are stored. At this stage, the information on name tags 2 and 3 is checked for consistency, and the metal detector inspection results are recorded on a special form. This process confirms that the recorded product identity remains consistent and provides a reference for affixing the barcode corresponding to both name tags. Details of the barcode are shown in Figure 3.

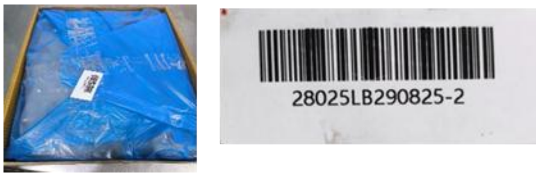

Figure 3. Barcode Placement and Production Barcode Model

The barcode on the inner carton identifies the product at the batch level within the company's internal traceability system. In PT Beejay Seafood's internal system, each commodity uses a specific identification code, such as "AG" for anggoli fish, which is listed on the export label under the trade name goldband snapper. These codes and trade names are intended to facilitate product identification both within the company's internal system and during external distribution. When products reach the final packaging stage and are ready to be stored in cold storage and distributed to buyers, the need for identification extends beyond internal purposes. At this stage, product identity must be presented more comprehensively and informatively via labels on the outer carton, which not only support warehouse management but also meet external traceability requirements. Therefore, the following discussion will outline the information listed on the outer carton labels of PT Beejay Seafood's frozen fillet products as part of the external traceability system.

Figure 4. Barcode Placement and Product Identification Barcode

The barcode label on the outer cardboard packaging of PT Beejay Seafood's frozen fillet products contains key information that serves as the final product's identity within the traceability system, particularly during storage and distribution.

The information identifiable on the label includes:

1. Product Name and Commodity Type: The label states Goldband/King Snapper (Pristipomoides multidens), indicating the trade name and scientific name of the fish commodity. This information is crucial for ensuring clarity regarding the product species within the traceability system and for meeting trade requirements.
2. Product Form and Specifications: The description skinless fillet indicates the form of the processed product, namely a fillet without skin. This description links the final product to the internal processing steps.
3. The I.W.P. (Individually Wrapped Product) designation indicates that each piece or portion of fish is individually vacuum-sealed in plastic before being placed into a bulk carton.
4. Product Size and Weight: The information 100–200 g indicates the product's size range, while 5 kg indicates the net weight of the product in a single carton. This data serves as the product's quantitative identifier in distribution systems and warehouse inventory records.
5. Product Code: Code 7300, as listed on the sticker, serves as the company's internal product code. This code facilitates quick identification of product types within the inventory tracking and management system.
6. Barcode and Identification Number: The barcode with the sequence of numbers 1 93 23015 01699 5 (as shown in the image) serves as the product's scannable digital identifier. This code links the physical product to digital data within the company's system, particularly during cold storage and distribution.

The information listed on the barcode sticker indicates that the outer cardboard packaging represents the identity of the final product in the traceability system. The barcode links the physical product to the company's information system (SIM Beejay), enabling traceability by product type, specifications, and quantity during storage and distribution. Thus, the barcode sticker on the carton is a key element in supporting external traceability, particularly in ensuring clarity regarding the products shipped to buyers and facilitating the traceback process when necessary.

External Traceability

External traceability is a tracking system that links the movement of products among actors in the supply chain, so the origin of raw materials and the distribution destination can be traced continuously (Pratama, 2025). Upstream, PT Beejay Seafood implements external traceability by recording supplier identities, commodity types, and raw material receipt dates during the receiving stage. The company then enters this information into its local system to control the origin of raw materials. Every supplier collaborating with PT Beejay Seafood must be registered in the company's system and have a supplier ID to control the source of raw materials. Additionally, suppliers must provide HACCP implementation documentation to verify that a food safety system is in place at the supplier level. This record-keeping allows the company to trace the origin of raw materials in the event of product non-conformities or quality issues, enabling the traceback process to be conducted more quickly and accurately. However, the traceability system currently in place is still limited to the supplier level and does not yet include more detailed information, such as the identity of the fishing vessel, the fishing area, or the fishing logbook.

On the downstream side, external traceability is implemented by recording product distribution based on the production code and barcode listed on the product's outer packaging. This information is used to identify the delivery destination, product quantity, and the production batch being distributed. PT Beejay Seafood's external traceability system remains reactive, with the traceback process conducted only when the buyer reports a complaint or product nonconformity. Under this mechanism, the company traces product batches using data stored in its internal system based on the production codes and barcodes listed on the packaging. This mechanism indicates that the implemented traceability system is not yet directly integrated through digital interoperability systems such as Electronic Data Interchange (EDI), but rather relies on internal information exchange within the company and traceability requests from buyers. Similar conditions are still common in the seafood industry's traceability systems, which have not yet fully implemented integrated digital systems across the supply chain (Hardt *et al*., 2017; Lewis & Boyle, 2017).

CONCLUSION

Implementing a traceability system at PT Beejay Seafood shows that differences in commodity characteristics affect processing stages and the need to record information at each stage of the production process. These differences require the traceability system to be tailored to each commodity's characteristics to ensure continuity of product identity and information flow from raw material receipt through distribution. An internal traceability system has been implemented using name tags, recording forms, production codes, and barcodes that are fully integrated, supporting both traceback and trace-forward processes throughout production.

Implementing Critical Control Points (CCPs) during raw material receiving and metal detector inspections supports quality control and strengthens the traceability system by controlling critical process points. Externally, the traceability system can trace the origin of raw materials down to the supplier level and link products to the distribution process. Although PT Beejay Seafood's traceability system can link product information from suppliers to distribution, the recording mechanism still relies on forms and the company's local systems, so data exchange among supply chain participants does not yet occur in real time. The development of cloud-based and blockchain-based digital traceability technologies offers opportunities to improve transparency, data integrity, and the efficiency of traceback and trace-forward processes through integrated data storage that is difficult to manipulate. Implementing these technologies is also expected to boost international market confidence in fishery products and support compliance with increasingly stringent traceability requirements in global trade.

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