

The Development of Strategies to Increase the Productivity of Fisheries Agro-industry Based on Halal Product Assurance System Using Failure Mode Effect Analysis (FMEA)

Strategi Peningkatan Produktivitas Agroindustri Perikanan Berbasis Sistem Jaminan Produk Halal (SJPH) dengan Metode Failure Mode Effect Analysis (FMEA)

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Abstract

Indonesian food products need to comply with halal regulations, including the ones from fisheries-based agro-industry. The absence of halal certificates will limit the market and consequently will lead to the risk of lower productivity performance. This study aims to identify sources of risk in the fisheries agro-industry based on Indonesia's Halal Assurance System called *Sistem Jaminan Produk Halal (SJPH)*. It conducts risk assessments and develops strategies to increase the productivity performance of the industry based on the identified risks. The criteria considered in the risk identification including commitment and responsibility, raw material, production process, final product as well as monitoring and evaluation. The research used Failure Mode Effect Analysis (FMEA). The data was collected through observation, interviews, and questionnaires. All identified risks were then evaluated and eliminated based on the Risk Priority Number (RPN). The research was conducted on ten fisheries-based agro-industries in the Sidoarjo Regency, East Java, Indonesia. The study shows that there are 22 sources of risk, with the highest-ranked one is training activity. The recommended strategy to increase the halal-based productivity performance is strengthening the commitment of all involved stakeholders, increasing human resources' knowledge, improving facilities and infrastructure as well as strengthening monitoring and evaluation using management information systems.

Keywords: FMEA, halal, risk management, SJPH

Abstrak

Produk pangan di Indonesia perlu memenuhi ketentuan halal, termasuk produk agroindustri perikanan. Ketiadaan sertifikat halal akan menyebabkan terbatasnya cakupan wilayah pemasaran dan berdampak pada risiko penurunan produktivitas. Penelitian ini bertujuan untuk mengidentifikasi sumber risiko di agroindustri perikanan berdasarkan Sistem Jaminan Produk Halal (SJPH), melakukan penilaian risiko, dan mengembangkan strategi untuk meningkatkan produktivitas berdasarkan risiko tersebut. Kriteria penentuan risiko adalah komitmen, bahan, proses produksi halal, produk, serta monitoring dan evaluasi. Metode penelitian menggunakan Failure Mode Effect Analysis (FMEA) dengan metode pengumpulan data melalui observasi, wawancara, dan kuesioner. Eliminasi risiko selanjutnya dilakukan berdasarkan peringkat Risk Priority Number (RPN). Penelitian dilakukan pada sepuluh usaha agroindustri perikanan di Kabupaten Sidoarjo, Jawa Timur. Hasil penelitian menunjukkan bahwa terdapat 22 sumber risiko, dengan risiko tertinggi pada kegiatan pelatihan, sehingga pihak yang terlibat dalam proses produksi halal tidak memahami ketentuan yang berlaku. Strategi peningkatan produktivitas berbasis risiko halal adalah penguatan komitmen pelaku usaha, peningkatan pengetahuan sumber daya manusia, peningkatan sarana dan prasarana, serta penguatan pemantauan dan evaluasi melalui pemanfaatan sistem informasi manajemen.

Keyword: FMEA, halal, manajemen risiko, SJPH

INTRODUCTION

Agro-industry provides opportunities for development capabilities to produce more attractive, high-quality, longer shelf life products, increasing the selling price, and added value (Prasetyo et al., 2018). Agro-industry is also one of the pillars of development that plays a strategic role in increasing income distribution and economic growth on both a regional and national scale (Timisela et al., 2017; Margahana, 2021). From an economic point of view, the agro-industry is a sector capable of absorbing a large number of workers, increasing business actors' and regional income, and encouraging innovations that can increase competitiveness (Gultom & Sulistyowati, 2018).

The fishery is one type of agro-industry that is continuously developing. The fishery agro-industry is an activity that manages and utilizes fish's resources and environment to provide added value (Wachdijono & Julhan, 2019). Various processed products from the fishery agro-industry are in demand by consumers because fish is a high protein source (Djamali & Betaubun, 2018). Products containing animal protein have increased along with the human population (Miguel Lenz et al., 2019). The fishery agro-industry growth is related to policies guaranteeing regional food availability (Ali et al., 2020).

Fishery agro-industry products are food materials consumed by people in Indonesia. These products need to obtain halal certificates because Indonesia has the largest Muslim population in the world (Wibawa et al., 2023). Halal is a mandatory requirement for food consumed by Muslims, as stated in the Al-Quran, Surah Al Baqarah Verses 168 and 172. The Indonesian government stipulates the obligation of halal certification for food in Article 4 of Law No. 33 of 2014 concerning Assurance for Halal Products. Halal certificates for fishery agro-industry products are related to this obligation and must meet consumer demands for purchase intention, satisfaction, and customer loyalty. Fawzee et al. (2021) explained that halal certificates encourage consumers' interest in buying food products. This was also expressed by Jumeri et al. (2021), who said that public awareness has increased in choosing safe, healthy, halal food and also indicated that halal certificates significantly affect customer satisfaction and loyalty.

Fulfillment of halal certification, increasing purchasing power, satisfaction, and consumer loyalty is the driving force for increasing the fisheries agro-industry productivity that catalyzes the development of other economic sectors such as tourism and banking (Nurrachmi, 2017). Increased productivity is also a decision-making instrument in the public policy sector to determine policies to increase the output of fisheries agro-industry business actors (Dorji et al., 2022). Therefore, fishery agro-industry business actors' awareness of implementing the halal product assurance system is essential. This is because business actors have a vital role in economic development through increased productivity (Suryani et al., 2022). Increasing productivity in the fisheries agro-industry is necessary to increase the living standard of business actors, balance product needs between supply and demand, and reduce unemployment (Ghosh & Biswas, 2017).

The Failure Mode Effect Analysis (FMEA) method can be used to develop strategies to increase fisheries' agro-industry productivity. The FMEA method is a systematic and proactive risk assessment method with a multidisciplinary background of factors (Liu et al., 2023). FMEA is presented based on the level of risk rating rationality measured by considering the severity, occurrence, and detection factors (Ouyang et al., 2022). Risk control using the FMEA method is needed because business actors can avoid losses that impact productivity (Suryaningrat et al., 2019). Business actors with a good understanding of their business risks have higher productivity than those without (Lien et al., 2022).

FMEA was used in this study to assess risk. The assessment results are then used to develop strategies to increase the fisheries' agro-industry productivity. The risks in this study were identified based on the criteria in the manual for the halal product assurance system called *Sistem Jaminan Produk Halal* (SJPH). SJPH is an assessment indicator in issuing halal certificates by the halal product assurance organizing agency called *Badan Penyelenggaraan Jaminan Produk Halal* (BPJPH). A product will not be halal-certified if one of the criteria in the SJPH is not met.

Research on increasing productivity based on risk is quite limited, so by implication, business actors do not understand the role of risk in productivity increase. Previous research on halal risks has been carried out by several researchers, including Wahyuni et al. (2020), Wahyuni et al. (2021), and Lestari et al. (2021). This study's results indicate activities that risk turning halal products into non-halal. Some of these studies have not used the criteria required by the Indonesian government through BPJPH to ensure the fulfillment of SJPH criteria.

The SJPH criteria were used in this study to determine the risks that form the basis for compiling strategies to increase fisheries' agro-industry productivity. The SJPH criteria used in this study are also to follow up on the Indonesian government's policies related to the obligation of halal certification for food products. This study aims to identify risk sources of fisheries agro-industry based on SJPH, conduct risk assessments, and develop strategies to increase productivity based on these risks. This study's results are expected to serve as guidelines for business actors to eliminate risks in producing halal products so their businesses can obtain halal certificates.

METHODS

This research was conducted on ten fishery agro-industries in the Sidoarjo Regency, East Java, with products such as crackers, meatballs, nuggets, smoked fish, and presto fish. The data collection methods were through surveys, interviews, and questionnaires. The survey was conducted by visiting the business location. The survey aims to determine the actual condition of business actors related to the SJPH aspects implementation in their production processes and to determine risk activities. The interview aims to determine business actors' understanding of SJPH aspect risks and agro-fishery activities risks. The questionnaire distribution aims to assess the fisheries agro-industry risk based on the SJPH aspect.

Halal Product Assurance System (SJPH)

The risks in this study were identified based on the criteria in the SJPH manual. SJPH is an integrated management system aiming to ensure the halal-certified product continuously. This system regulates all those involved in producing goods or services, such as raw materials, processes, products, human resources, and procedures (Hamidatun & Pujilestari, 2022). The SJPH criteria that must be met to obtain a halal certificate are shown in Table 1.

Table 1. SJPH criteria

Criteria	Description
Commitment and responsibility	<ul style="list-style-type: none"> Business actors show their commitment and responsibility to produce halal products. The commitment and responsibility of business actors are shown by the availability of halal policy documents.
Material	<ul style="list-style-type: none"> Business actors must comply with the provisions on using the material, which consists of assured halal material to produce products.
Production process	<ul style="list-style-type: none"> Business actors must maintain business locations, production sites, equipment, and production facilities so they are hygienic, without contamination from <i>najis</i> (defiling filth) or haram materials. Business actors must handle products that do not meet halal criteria by destroying them and are prohibited from selling them to consumers.
Final Product	<ul style="list-style-type: none"> Business actors must fulfill requirements related to the products produced, tools/materials used, labeling, and product names.
Monitoring and evaluation	<ul style="list-style-type: none"> Business actors need to use internal audit procedures conducted by halal supervisors. Internal audit implementation documents need to be kept and reported to BPJPH. Business actors must immediately take corrective action if an internal audit finds discrepancies with SJPH.

Failure Mode Effect Analysis (FMEA)

The FMEA stages used in the study were developed based on the stages conducted by Ullah et al. (2022), shown in Figure 1. The survey results of business locations are used as a basis for identifying risk sources. Risk determination is then conducted through interviews with expert respondents. Expert respondents in this study were ten business actors/owners, two field extension officers from the regional fisheries service who were experts in the fishery agro-industry, and two assistants in the halal products process who were experts in SJPH.

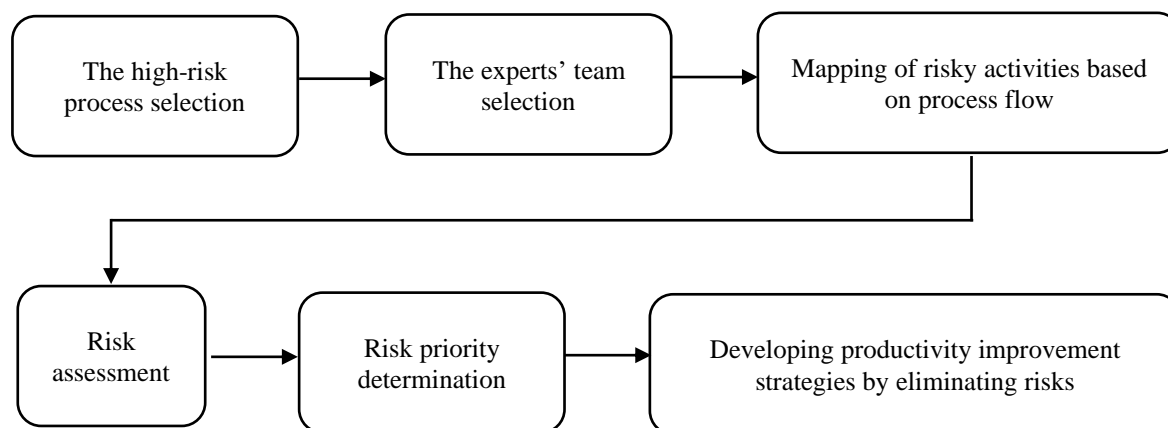


Figure 1. FMEA Stages (Ullah et al., 2022)

Risk assessment was then completed by filling out questionnaires by all expert respondents. The questionnaire was prepared following the FMEA method provisions to assess the risk of severity (S), occurrence (O), and detection (D) based on the fisheries agro-industry SJPH. The severity assessment is based on the impact severity when the risk occurs, the occurrence is based on the risk event frequency, and detection is based on the sensitivity level of detecting risk events. The S, O, and D ratings refer to the scale developed by Ebrahimi et al. (2022), shown in Table 2.

Table 2. Rating scale S, O, and D

Severity	Occurrence	Detection	Rating Scale
None	Near impossible	Almost certain	1
Very minor	Remote	Very high detectability	2
Minor	Low	High detectability	3
Low	Relatively low	Moderately high detectability	4
Moderate	Moderate	Moderate detectability	5
Significant	Moderately high	Low detectability	6
Major	High	Very low detectability	7
Extreme	Repeated failure	Remote detectability	8
Serious	Very high	Very remote detectability	9
Hazardous	Extremely high	Absolute uncertainty	10

Source: Ebrahimi et al. (2022)

The Risk Priority Number (RPN) is then calculated using the following equation:

$$\text{RPN} = \text{S} \times \text{O} \times \text{D} \quad (1)$$

A risk control map is then made to determine whether the risks in the fishery agro-industry under study are under control. Risk can be controlled if the RPN value is within the control limits. The upper control limits and lower control limits of the control chart are as follows (Matondang et al., 2023):

$$\text{CL} = \bar{x} = \frac{\sum x}{N} \quad (2)$$

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{N - 1}} \quad (3)$$

$$\text{UCL} = \bar{x} + 3\sigma \quad (4)$$

$$\text{LCL} = \bar{x} - 3\sigma \quad (5)$$

Where,

x: RPN value

N: risk amount

σ : RPN value standard deviation

CL: control line

LCL: lower control limit

UCL: upper control limit

The question instrument in the questionnaire refers to SJPH aspects listed in the Decree of the Head of the Indonesian Halal Product Assurance Organizing Agency No. 57 of 2022 concerning the Manual for Halal Product Assurance Systems for Halal Certification with a Statement of Business Actors for Micro and Small Enterprises (Self Declare). The SJPH aspects of identifying risk sources include commitment and responsibility, material, production process, final product as well as monitoring and evaluation. All of these aspects must comply with halal requirements. The product risks not obtaining halal certification if one or more aspects do not meet halal requirements. The selection of risk aspects is based on the questions used in the internal audit of halal products in the SJPH manual.

The risk assessment results are then used as a basis for eliminating risks. A strategy to eliminate risk is formulated using brainstorming with expert respondents and based on literature studies. The productivity of the fishery agro-industry is expected to increase by eliminating these risks.

RESULTS AND DISCUSSION

Risk Identification

Risk sources were observed on ten fishery agro-industry business actors with the identities shown in Table 3, while examples of fishery agro-industry products are shown in Figure 2. The identification results of risk sources in the fisheries agro-industry based on SJPH are shown in Table 4.

Table 3. Entrepreneur identity

No	Product Types	Object Total	Halal Certificate
1	Meatball	1	Certified
2	Nuggets	1	Certified
3	Crackers	3	Certified
4	Smoked fish	3	Uncertified
5	Sergestid shrimp	1	On Process
6	Dimsum	1	Certified



(a) Fish meatball



(b) Fish crackers



(c) Anchovy



(d) Fish skin chips



(e) Sergestid shrimp



(f) Smoked fish

Figure 2. Examples of Fisheries Agro-industry Products

Table 4. Sources of risk in the fishery agro-industry based on SJPH

SJPH Aspects	Risk Source	Code	Risk Causes
Commitment and responsibility	Halal policies determination	A1	• Not understanding halal policies
	Halal policies dissemination	A2	• Not having commitment and responsibility toward halal policies
	The person responsible for the halal policy	A3	• Dissemination of halal policies has not been carried out • The socialization process is not documented • No staff is appointed as the person in charge of the halal policy. • There has been no briefing on the function of the person in charge of the halal policy
	Written procedures for halal training	A4	• Do not understand the principles of training • Undocumented training procedures
	Halal training	A5	• The resources needed for halal training are not yet available • No documentation of halal training
Material	Main raw material	A6	• The materials are not halal certified
	Additional material	A7	• There is no separation of halal and non-halal products in the material distribution system
	Auxiliary material	A8	• There is no record of the material used
	Raw material transportation	A9	• There is no inspection process for incoming material
	Washing agent	A10	
Halal production process	production facilities	A11	• Contaminated with najis material
	Production room	A12	• Contaminated with haram material
	Product distribution	A13	• The material stored are not halal certified
	Product storage	A14	• Does not have a subscription procedure for products that do not meet halal criteria
	Product handling does not meet halal criteria	A15	
Final Product	Product name	A16	• Haram animal symbols
	Product form	A17	• The product shape resembles haram objects or animals
	Product taste	A18	• Name towards badness.
	Product aroma	A19	• Has the smell of haram objects • Having a taste of haram objects
Monitoring and Evaluation	Internal audit schedule	A20	• Do not have internal auditors
	Internal audit results	A21	• Not understanding the internal audit process • Audit results are not disseminated
	Socialization of internal audit results	A22	• There is no follow-up on audit results

Risk Assessment

A risk assessment is then conducted to assess S, O, and D. The assessment is to determine the RPN value and RPN ranking, which are shown in Table 5. The RPN value indicates the level of risk posed by each risk source. The higher the RPN value, the higher the risk at that source (Figure 3). The highest RPN value is a priority for taking action to eliminate risks.

Figure 3 shows that the highest risks are in halal training (A5) and product names (A16). The lowest risk is production facilities in fishery agro-industry businesses. A risk control map is then created based on the RPN value. The control line values calculated using formulas (2) to (5) are $CL=146.05$, $LCL = -294.01$, and $UCL = 586.09$.

Table 5. Fisheries agro-industry risk assessment based on SJPH aspects

Risk Activity Code	Assessment			RPN	Ranking
	S	O	D		
A1	7	7	8	392	3
A2	5	6	5	150	7
A3	5	5	5	125	9
A4	5	4	4	80	12
A5	7	8	8	448	1
A6	7	6	5	210	6
A7	5	5	4	100	10
A8	4	5	5	100	11
A9	3	3	4	36	17
A10	3	4	4	48	15
A11	2	2	4	16	22
A12	3	3	2	18	19
A13	3	3	2	18	20
A14	3	4	4	48	16
A15	3	3	2	18	21
A16	8	7	8	448	2
A17	4	4	5	80	13
A18	4	3	5	60	14
A19	4	3	2	24	18
A20	7	7	8	392	4
A21	7	6	6	252	5
A22	5	5	6	150	8

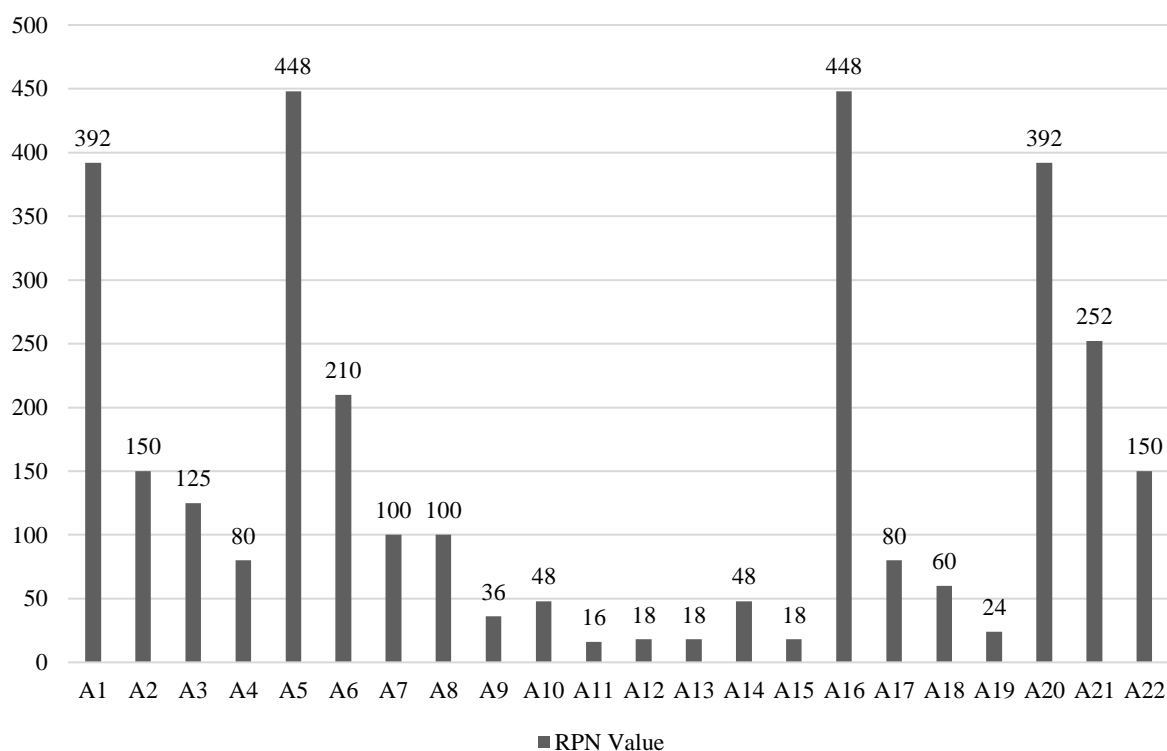
**Figure 3.** Fishery Agro-industry Risk Priority

Figure 4 shows that the overall risk is at the control line, as indicated by the RPN value between the UCL and LCL. Figure 4 also shows that 8 (36.3%) activities in the fishery agro-industry have risks above the average. Risk sources that can cause risk events above the average are A1, A2, A5, A6, A16, A20, A21 and A22. Even though all risk sources are within control limits, corrective actions must still be

implemented to eliminate the impact on productivity and anticipate that there are no risk sources whose risk events exceed control limits in the next period. The risks are then grouped based on the SJPH criteria, and risk mitigation is conducted based on the risk priority in each SJPH criteria, as shown in Table 6.

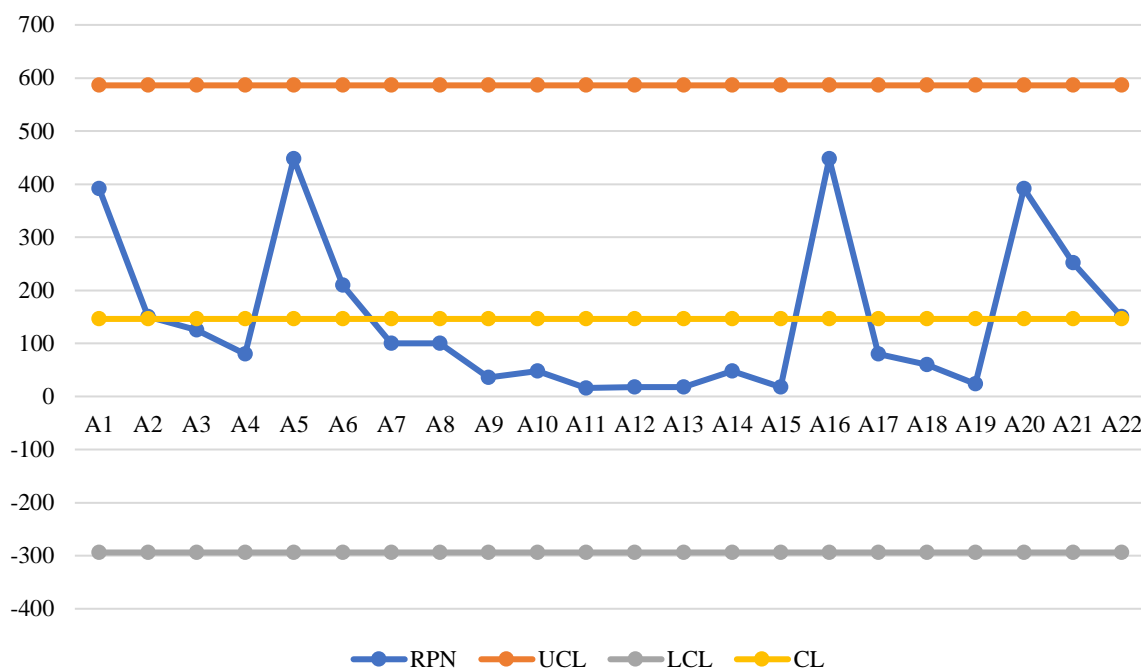


Figure 4. Fisheries Agro-industry Risk Control Map

Table 6. Risk priority based on SJPH criteria

Commitment and Responsibility		Material		Halal Production Process		Product		Monitoring and Evaluation	
Priority	Code	Priority	Code	Priority	Code	Priority	Code	Priority	Code
1	A5	1	A6	1	A14	1	A16	1	A20
2	A1	2	A7	2	A12	2	A17	2	A21
3	A2	3	A8	3	A13	3	A18	3	A22
4	A3	4	A10	4	A15	4	A19		
5	A4	5	A9	5	A11				

Halal training is a top priority that needs immediate attention to the criteria for commitment and responsibility (A5). Halal training is essential to do by business actors to increase self-understanding and all parties involved in the halal production process. Activities to add insight and knowledge through halal training can increase product productivity and competitiveness (Agustina et al., 2019). Training is a way of developing human resources to increase competency to help business actors in business development (Rodriguez & Walters, 2019). Human resources are essential in increasing business productivity, so companies must plan effective training programs to improve skills and knowledge (Salah, 2016). Increased productivity through training can occur because increased human resource skills encourage additional sales value and product-added value so that business actors can expand their market share (Martins, 2021). Commitment and responsibility at the level of business actors are shown by active participation in every training activity organized by various agencies.

The main raw material (A6) is a top priority that must be controlled to keep the product halal. The provisions in the SJPH manual stipulate that the raw material used already have a halal certificate or are in the positive list category. Material on the positive list is exempt from the obligation to be halal certified. Based on the provisions of the Decree of the Indonesian Minister of Religion No. 1360 of 2021, the positive list are materials originating from nature in the form of plants and mining materials without

processing, not at risk of containing haram materials, not classified as hazardous materials and are not in contact with haram materials. Some products in the positive list category include fresh fruit, fresh vegetables, dried vegetables, fresh tubers, dried tubers, and nuts. Some raw materials have a risk of containing haram elements but are not realized by business actors, such as gelatin. One of the fishery agro-industry products that use gelatin is fish paste. Gelatin is a food raw material as a thickener and binder that improves texture (Sani et al., 2015). One material often used to make gelatin is pork bone or skin, but currently, gelatin is also produced from halal animal bones, such as fish, chicken, or beef (Fasya et al., 2018).

Halal material utilization also has a positive impact on the development of the human body, especially on body weight, muscle mass, body fat, and human antioxidant status, without changing the gut microbiota and levels of biomarkers such as glucose, insulin, or iron (Carrasco et al., 2022). Fish is the main raw material used in the product as the object of this research. Fish is a low-risk material for halal contamination as it does not use slaughter processes. The additional food material used, such as flour, oil, and other material, must be ensured from the fish-based products.

The main priority for risk control in the criteria for the halal production process is product storage (A14). One of the risks in the product storage room is contamination from najis or haram material. Business actors must prepare warehouses with facilities to ensure product halalness so products are free from haram contamination. These facilities include warehouse buildings (floors and walls), racks/pallets, forklifts, and conveyances for transportation (trucks) (Saribsanon et al., 2019). Separation / extending the distance between products can also be done to maintain product halalness in the storage warehouse (Kwag & Ko, 2019).

In the final product criteria, the product name (A16) is the main priority at risk of not complying with SJPH. The product name or brand is an essential part of business actors. The product brand is an aspect consumers consider buying a product (Permata et al., 2019). Therefore, business actors tend to use unique product names that interest consumers. Several business actors have not paid attention to the SJPH provisions, which state that names/symbols/shapes cannot lead to disbelief, evil, or illicit objects. This provision follows the research results by Romdonny & Rosmadi (2018). The results of this study explain that brands must create a positive product image for consumers so that brands can foster consumer confidence to purchase these products. Some business actors give their products names that lead to disbelief to attract attention and grow curiosity to direct consumers to buy them. These names use the words hell, devil, and ghost as product names.

In the monitoring and evaluation criteria, the audit schedule by the internal auditor (A20) is a top priority. This is because business actors in the fisheries agro-industry do not yet understand the role and process of internal audit implementation as a form of monitoring and evaluation criteria implementation. Business actors also do not yet have a halal supervisor who can be an internal auditor for their business. The task of the halal supervisor, in general, is to ensure that the production process runs according to the provisions in the SJPH.

Productivity Improvement Strategy

Risks in every production process of fishery agro-industry impact business productivity, so formulations to eliminate or anticipate these risks need to be formulated through risk mitigation. Risk mitigation is crucial in increasing productivity to support business continuity (Afifa & Santoso, 2022). Risk mitigation, as one of the stages in risk management, can maintain stable business income amidst uncertainty so that business actors can maintain their productivity (Silva et al., 2021; Vigani & Kathage, 2019; Kurniawan et al., 2017).

The formulation of a productivity improvement strategy based on SJPH risk in the fishery agro-industry is the socialization of the halal production process to business actors, training, and mentoring business actors, providing specific facilities and infrastructure for the halal production process, and designing a management information system for monitoring and evaluating halal products. All parties, such as the government, universities, or others interested in halal products, must socialize the halal production process. This activity aims to provide understanding to business actors to carry out the production process following halal provisions to avoid the risk of contamination.

Training and mentoring are needed for all parties involved in the halal production process. All parties must obtain information regarding procedures and mechanisms for halal production. This is necessary so

that all parties can play a role in producing halal products according to their functions. For example, suppliers play a role in preparing halal raw materials by providing halal-certified materials. Supplier awareness is needed for halal certification on products sent to the next business actor. Linkages between parties are needed to maintain product halalness according to their roles. Utilization of technology through social media and online training systems can be carried out so that the reach of socialization and training is wider. The flexibility of social media and online training systems make the halal production process known and understood quickly by many.

The following risk mitigation can be done by redesigning the facilities and infrastructure owned by business actors. The redesign separates the facilities and infrastructure used to produce products submitted for halal certification and those not certified. This separation needs to pay attention to the location position and the area of production space used. For example, in the fishery agro-industry, this can be seen in the separation of raw material rooms, production rooms, and finished product storage rooms. This is important to note to maintain human resources' comfort and work safety. This redesign is closely related to business owners' commitment to implementing the halal production process because this step often requires investment costs.

Risk mitigation in monitoring and evaluation systems in the industrial 4.0 era can also be done by developing a management information system (MIS). MIS is designed to facilitate business people and halal supervisors in the documentation system, such as recording materials purchases, production results, purchase types, and others, to facilitate tracing materials and products during internal audits. MIS also needs to be designed so that monitoring and evaluation results can be documented and disseminated to all parties to be used as a basis for taking corrective actions.

CONCLUSIONS

Fisheries agro-industry is one of the agro-industries that plays an essential role in supporting the economy of Indonesia. This research identified risk sources in the halal certification process based on the provisions of the Halal Product Assurance System (SJPH), which can affect the increase in the productivity of fisheries agro-industry businesses. The results of risk identification show that there are 22 sources of risk in the fisheries agro-industry. This source of risk may result in the failure of halal certification if not properly controlled. Sources of risk are formulated based on five criteria in SJPH. The highest risks are in halal training and product names. Risk mitigation is then conducted through implementing the dissemination of the halal production process, training and mentoring, providing facilities and infrastructure, and designing an information system for monitoring and evaluating the process of halal products.

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