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# IDENTIFICATION OF FOOD FRAUD VULNERABILITY FACTORS FOR IN THE SPICE INDUSTRY

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***Keywords***

*control actions, food fraud, motivation, opportunities, vulnerability*

**ABSTRACT**

Food fraud is a serious problem in the spice industry. This research aims to identify the potential for food fraud in spice commodity supply chain using the Food Fraud Vulnerability Assessment Tool from the Safe Supply of Affordable Food Everywhere (SSAFE). The research was conducted through a case study on two spice commodity industries, namely PT A and PT B, located in Jakarta and Tangerang from June to December 2023. The results of the study indicated that the opportunity factor, the motivation factor, and the control action indicator have high vulnerability in both companies, while in the control action factor, there are indicators that have low vulnerability in PT Y. The preparation of mitigation strategies was obtained from the analysis of the relationship between vulnerability factors, opportunities, motivations and control measures which were then validated from literature sources. Based on the conclusion of the food fraud vulnerability analysis in this study, there were several suggestions that can be put forward to improve the strategy of handling food fraud.

## INTRODUCTION

Increasing public awareness of the availability of food that is safe for consumption requires the food industry to regulate a good food safety system. The identification of the food safety system must be analyzed in the entire food supply chain from raw materials to the food received by consumers, to avoid or reduce the risk of changes in food conditions and the danger of contamination (Bouzembrak & Marvin, 2016). Along with food safety issues such as microbiological, chemical and physical hazards in the food chain, the threat of food contamination can occur due to deliberate food fraud (Spink et al., 2016). Food fraud is an act of food destruction by deliberately replacing or adding harmful or improper ingredients to food, as well as providing false and misleading product information with the motivation of economic profit (Global Food Safety Initiative (GFSI), 2014). The opportunity to commit food fraud is very large in a country if there is a process of importing and exporting food and the country has the ability to produce a large amount of food (Galvin-King et al., 2018). The geographical area of a country also affects the chances of committing food fraud. In developing countries such as Indonesia, with

unstable political and social conditions and a large population, the potential for food counterfeiting is higher (United States Pharmacopeia, 2016).

Data from the ASEAN Rapid Alert System for Food and Feed (ARASFF) shows that out of a total of 145 food counterfeit notifications throughout ASEAN, spices and spices are the products with the highest frequency of counterfeiting reporting reaching 15.2% (n=22) from 2007 to 2020. Of these, 72% of the spices and spices commodities come from Indonesia. A very high incidence of food counterfeiting was reported in 2016 with 21 notifications of which Indonesia contributed 16 notifications related to reporting food counterfeiting for spices & spices commodities. The number of such notifications is significantly higher than in other countries. Spices are food commodities that have the potential to be counterfeited because they have a high selling value and low capacity to detect their authenticity by consumers. Especially if the spices have gone through the grinding process into powder (Spink et al., 2016). Spices are generally adulterated with the addition of low-quality ingredients or the addition of prohibited dyes to improve the appearance of the product (Black et al., 2016).

The demand for world spice commodities has an increasing trend with a demand rate of 10.38% per year and Indonesia is one of the 5 largest spice producing countries in the world. Therefore, an appropriate vulnerability monitoring system is needed in food counterfeiting so that Indonesia's original spice commodities can compete with other countries. Since 2018, the Global Food Safety Initiative (GFSI) has required every industry to be certified to implement controls related to food fraud because food fraud is already included in its food safety management system. The food fraud control measures that have been carried out in Indonesia have not focused on identifying opportunities that may occur in each supply chain as the root cause of food fraud. Its application is also still rare, especially in the spice industry which is known to have a high vulnerability to food fraud. Therefore, it is necessary to conduct a study to identify food fraud vulnerability factors in the spice industry using a reference from the Safe Supply of Affordable Food Everywhere (SSAFE) institution. The results of the identification of food fraud vulnerability factors are expected to be used as material for the preparation of mitigation strategies to be implemented in the spice industry in Indonesia.

Spice commodities are commodities with high selling value, so there is the potential for food fraud by various parties. The long and complex spice supply chain presents many opportunities for counterfeiters to fulfill economic benefits. The root cause of food fraud and the factors that are vulnerable to food fraud have not been widely researched in Indonesia today. The study of the identification of these vulnerability factors can produce information that will be used to develop mitigation strategies against the risk of food fraud in the industry.

The research aims to identify the potential for food fraud in the spice commodity supply chain using the Food Fraud Vulnerability Assessment Tool from SSAFE. The potential food fraud identified is used to develop mitigation strategies. The research was conducted through a case study on two seasoning processing industries. The scope of the research starts from the identification of the main factors of food fraud vulnerability using the Food fraud Vulnerability Assessment Tool from SSAFE and the preparation of mitigation strategies that will be submitted to the industry to be studied as an evaluation in assessing the vulnerability factors in food fraud. This research is expected to provide a new perspective related to food fraud in the spice industry and provide control strategies on the identified potential. The general benefit that is expected from the research is that it can provide insight into the study of food fraud vulnerability factors in the spice industry supply chain as input for the industry to develop guidelines in implementing food safety systems.

## METHODS

The research was conducted on two spice commodity industries, namely PT X and PT Y located in Jakarta and Tangerang from June to December 2023. This research uses several tools, namely mobile phones, laptops, and recording devices. Meanwhile, the material in this study is a SSAFE questionnaire consisting of 50 questions. The SSAFE questionnaire describes three key elements of food fraud

vulnerability, namely opportunity, motivation, and control actions. In the questionnaire, the scoring criteria for each question have been determined.

The research was carried out using primary and secondary data. Primary data was obtained from interviews with respondents using Gform , FFVA tools , and interview. Secondary data are obtained from relevant scientific publications and literature. The stages of this study are (1) Preparation of FFVA tools (2) Dissemination of FFVA tools questioner (3) Data Verification & Interviews (3) Data analysis and (4) preparation & delivery of mitigation strategies.

1) Preparation of the Food fraud vulnerability assessment tool: The original questions in the English questionnaire were translated into Indonesian by adjusting some word structure to be included in the context of the condiment food category. The questionnaire will be tested to assess the adequacy of the survey material. The questionnaire test was carried out to ensure that the questions in the questionnaire were appropriate in terms of language and avoid amiguity. Based on the results of the trial, a modified questionnaire was carried out.

   In this questionnaire trial, the validity and reliability of the questionnaire were also analyzed. The main indicator of a measurement instrument is its validity and reliability. Reliability tests were conducted with Cronbach's alpha (Kimberlin and Winterstein 2008). Meanwhile, validity can be defined as the extent to which a measurement instrument can measure what is desired (Kimberlin and Winterstein 2008). The validity test was carried out with Pearson correlation.

2) Data Verification & Interview: The questionnaire was design by goggle form and are given to related respondens.. There are 50 queries in FFVA tools. Each question has one final answer that is selected based on the options contained in the questionnaire. Interview recording is carried out with the permission of the respondent for research documentation needs after the questionnaire is filled correctly. Each answer during the interview is matched with the score conditions that are already in the questionnaire. The questionnaire is divided into 3 indicators, namely opportunity, motivation and control action. The determination of vulnerability assessment scores for the three indicators is described in Table 1.

**Table 1.** Scoring of each element

| Score | Opportunity & motivation indicators | Control Actions |
|---|---|---|
| 1 | Low vulnerability identification (Food Fraud Control Already in Place) | High vulnerability (no surveillance system) |
| 2 | Identify moderate vulnerabilities (Food fraud control already exists but is simple) | Moderate vulnerability (weak surveillance system) |
| 3 | Identification of high vulnerabilities (no food fraud control) | Low vulnerability (strong surveillance system) |

3) Data Analysis: The results of determining the score from the 50 questions given will identify the vulnerability of food fraud in each company. The identification is based on the answer score from the questionnaire which will then be automatically mapped on excel from the standard questionnaire by SSAFE. The results obtained were in the form of spider web diagrams of each indicator from two companies. In the opportunity and motivation indicators, if the spider web diagram surface is larger, it shows the identification of high food fraud vulnerabilities which means that special attention is needed. The same thing is also defined in the spider web indicator of control actions, if the surface area is getting larger, it indicates that specific controls have been carried out.

   Furthermore, from the results of the identification of vulnerabilities of each company, an exploratory analysis will be carried out using the SCA method. SCA was used to determine the most influential food fraud vulnerability factors and explore the differences in these vulnerability factors between the two companies analyzed. This method can find out what elements have high vulnerability as a consideration in determining mitigation strategies. In addition, the Chi Square Test will be used to test the difference in the level of vulnerability of the two companies. The Chi Square test is useful for testing the relationship or influence of two nominal variables and measuring the strength of the relationship between one variable and another nominal variable.

The preparation of mitigation strategies is analyzed based on the results that have been obtained. The preparation of mitigation strategies was obtained from the results of the analysis of the relationship between vulnerability factors, opportunities, motivations and control measures which were then validated from literature sources.

## RESULTS

### Food fraud vulnerability mapping in both companies

#### *Opportunity Factor*

For the type of opportunity factor data, it is expressed in the form of a scale, namely a score of 1 for low vulnerability, a score of 2 for medium vulnerability, and a score of 3 for high vulnerability. Based on the results of data processing collected from respondents in both companies, the results of mapping for the opportunity factor for food fraud in PT A and B are shown in the following figure 2:

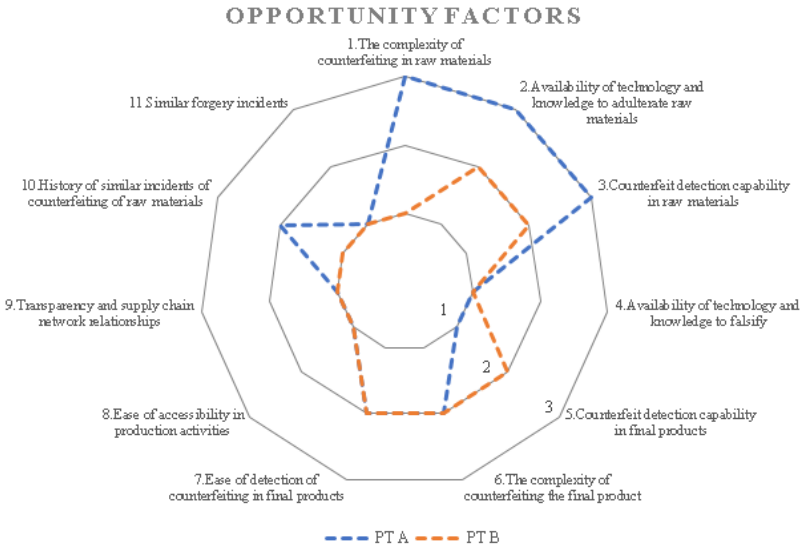


**Figure 1.** Results of the mapping of opportunity factors of PT A and PT B

It is known that in PT A and PT B together there are indicators that show the same vulnerability value in the two companies because the value of each indicator is the same, namely indicator number 4 about technology availability, number 8 about production process description, number 9 about supply network transparency, and number 11 about incidents food fraud. This shows that in indicator 4, both companies have a low level of vulnerability related to the availability of technology. This can be interpreted that both companies have been adequate in adopting technology that can support food safety for seasoning production even though this aspect is one of the aspects that often becomes a gap in action food fraud (Huisman & van Ruth, 2022). The two companies were identified as having applied some of the latest machine technology in producing spices such as solar dryers with solar cell, spice grinding machine (grinder machine), and packaging machines (sealer machine) which is able to maintain the quality and quality of the processed spices (Aisyah et al., 2020). The value of indicator number 8 shows that just like in the previous indicator, PT A and PT B have a low level of vulnerability related to the description of the production process. This signifies that both have good documentation and understanding of the production process, reducing potential vulnerability to food fraud (Cavin et al., 2018). In addition, at the value of the indicator 9, it indicates a low level of vulnerability on the supply network transparency indicator, indicating that both have a transparent supply network, minimizing the risk of food fraud related to the supply chain which is a crucial point in terms of the production process (Gussow & Mariët, 2022). This supply chain risk can be suppressed because the downstream process of seasoning raw materials in both companies has been carried out by adopting supply chain management audited. Meanwhile, indicator number 11 illustrates that both companies have a low level

of vulnerability related to incidents food fraud, especially at the incident stage food fraud. This shows that both PT A and PT B can minimize the occurrence or incident food fraud in the past when this can be a driver for action food fraud Next (Soon & Mei, 2019).

As for other differences in opportunity factors, there are differences in the level of vulnerability. As in indicator number 1 about the complexity of raw materials, it can be seen that PT A has a high level of vulnerability while PT B has a low level of vulnerability. The difference in vulnerability levels between PT A (high) and PT B (low) in this indicator indicates that the type or complexity of the raw materials used by the two companies is different. PT A uses more complex raw materials because it consists of more than 3 materials so that it is vulnerable to food fraud. Thus, if the raw materials used are simpler and still able to maintain quality, it will reduce the possibility of food fraud (Everstine et al., 2020). Meanwhile, in indicator number 2 about technology and knowledge, number 3 about the ability to detect material mixtures, number 6 about the complexity of counterfeiting final products, and number 7 about detecting counterfeiting of final products, it can be seen that PT A has a high level of vulnerability, while PT B has a medium level of vulnerability. This can happen because there has been an incident at PT A food fraud With only simple technology and the company has not been able to detect fraud from the mixed phase of the material and the final product, it means that the level of security is not high (Manning, 2016).

On indicator number 10 about the incident food fraud It can be seen that PT A has a medium level of vulnerability and PT B has a low level of vulnerability. This shows that in both companies it has happened recovery on the aspect of vulnerability food fraud on similar raw materials. The difference in vulnerability levels in this indicator shows that although PT A still has a less effective handling strategy than PT B which has succeeded in reducing the vulnerability related to the incident food fraud on the raw materials of seasoning products (Owolabi & Olayinka, 2021). As for the last aspect number 5 regarding the ability to detect pollution in the final product of PT B has a medium level of vulnerability, on the contrary, PT A has a low level of vulnerability. This shows that PT A is able to ensure that there is no contamination in the final product better than PT B.

Based on the analysis of the opportunity to use the web spider in each company, it can be concluded that the low level of vulnerability in both companies means that the opportunity for food fraud in these four indicators is narrower. Although both companies have many medium and low vulnerabilities in these factors, differences on certain factors indicate the existence of potential for improvement. By focusing on factors that have a high level of vulnerability, companies can strengthen security and detection measures to reduce the overall risk of food fraud.

**Motivational Factors**

For the type of data motivational factor, it is also expressed in the form of a scale, namely a score of 1 for low vulnerability, a score of 2 for medium vulnerability, and a score of 3 for high vulnerability. Based on the results of data processing collected from respondents in both companies, the results of mapping for motivational factors for food fraud in PT A and B are shown in the following figure 3:


**Figure 2.** Results of mapping the motivational factors of PT A and PT B

It is known that in PT A and PT B together there are indicators that show the same vulnerability value in the two companies because the value of each indicator is the same, namely in indicator number 14 about the company's economic condition, number 15 about the condition of the company's business strategy, number 17 about past criminal incidents, number 19 about the description of the company's financial pressure on suppliers, Number 20 about the economic condition of suppliers, number 21 about the strategic business of suppliers, and number 23 about criminal acts of suppliers, number 26 about the economic conditions of the supply chain, number 27 about the credibility of suppliers, and number 28 about the business ethics of the industry and its suppliers. This shows that from several aspects of the motivational factor in the two companies have a low level of vulnerability. This is suspected to have occurred because the two companies have audited and monitored the company's financial condition, suppliers, as well as the situation and business strategies that are carried out so that they have a low level of vulnerability even though some of these indicators are indicators that often motivate the fraudster in taking action food fraud (Yang et al., 2022). Although there are similarities in values on indicators of the company's economic condition, business strategy, past criminal incidents, financial pressure on suppliers, suppliers' economic conditions, suppliers' business strategies, suppliers' criminal acts, supply chain economic conditions, suppliers' credibility, and industrial and supplier business ethics, it shows that the two companies have managed these factors well. Audit and monitoring practices carried out by companies help in identifying and addressing potential risks in various aspects of operations.

As for number 18 regarding the level of corruption, the state has a high level of vulnerability in both companies. This shows that the Indonesian state, which is the home of the two companies, is still open to corruption, especially in the manufacturing sector (Permatasari & Prastiwi, 2023). Thus, the company must mitigate the possibility of this happening. In number 12 about the supply and price of raw materials, number 13 about special attributes that determine the value of raw materials, and number 30 about the level of industrial competition, it can be seen that PT B has a high level of vulnerability, while PT A has a medium level of vulnerability. This shows that PT B has not been properly mitigated regarding the special attributes used for assessment and competition in the industry which is very tight so that it opens up opportunities for food fraud (Lord et al., 2022). In number 25 regarding the level of corruption in the supplier's country of origin, it can be seen that PT A has a high level of vulnerability while PT B has a medium level of vulnerability. This can happen because PT A has suppliers from within the country or in Indonesia who have a high level of corruption, while PT B has suppliers

from abroad (Usman et al., 2021). In number 16 about the company's business culture or ethics and number 22 about the supplier's business culture and ethics, it can be seen that PT A has a medium level of vulnerability and PT B has a low level of vulnerability. This shows that the culture and ethics both within the company and from the supplier have a better implementation of honesty values in PT B. Internal and this good culture will narrow the possibility of occurrence food fraud Because the internal members of the company have high integrity and responsibility (Soon et al., 2019). At number 24 on the victimization of suppliers and 29 on actions food fraud In the past, in similar industries, it was seen that PT B had a medium level of vulnerability and PT A had a low level of vulnerability. This shows that in terms of supplier victimization and history of criminal acts in the industry in PT A is more vulnerable than in PT B even though this factor will greatly encourage the occurrence of food fraud (Barrere et al., 2020).

Overall based on results spider web, the two companies have similarities in managing internal aspects of the company such as economic conditions, business strategies, and business ethics. However, there are differences in external aspects such as the level of state corruption, supplier conditions, special attributes of raw materials, and the level of industrial competition (Yang et al., 2022). This analysis can be the basis for both companies to strengthen their risk mitigation strategies food fraud from the motivational factor, especially by focusing on aspects that are still vulnerable such as state corruption and supplier management. There are several things that can be done by the two companies to overcome some of the gaps in these motivational factors such as increasing cooperation with relevant authorities and institutions to reduce the level of corruption at the country level, implementing more intensive risk management is needed to overcome uncertainties in the supply of raw materials, especially for PT B which has a high level of vulnerability, strengthen the values of business ethics and honesty both within the company and in the supply chain to continue to monitor and evaluate regularly to ensure that the risk mitigation measures taken are effective in reducing vulnerability to food fraud.

***Control Action Factors***

For the data type, the surveillance factor has a different form of scale from other factors, namely a score of 1 for the absence of control action or showing high vulnerability, a score of 2 for weak control action or showing moderate vulnerability, and a score of 3 for strong control action or showing high vulnerability. Based on the results of data processing collected from respondents in both companies, the results of the mapping for the supervisory factors for *food fraud* in PT A and B are shown in the following figure.

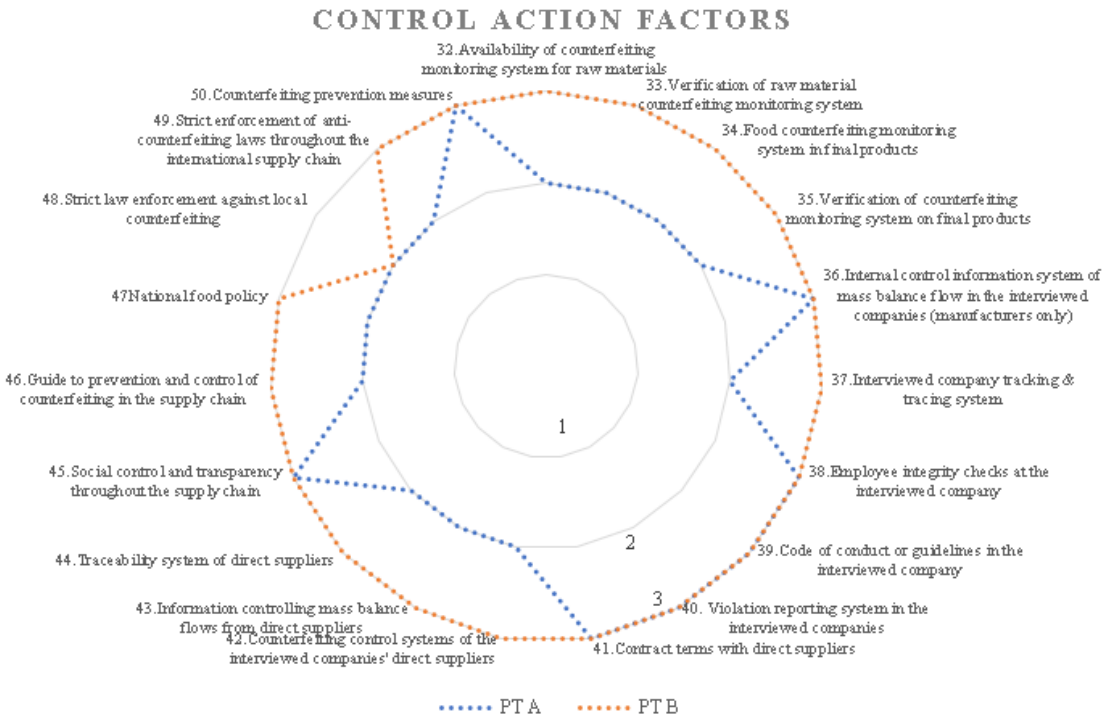


**Figure 3.** Results of mapping the control action factors of PT A and PT B

It is known that in PT A and PT B together there are indicators that show the same vulnerability value in the two companies because the value of each indicator is the same, namely in indicator number 36 about the company's information system related to stock checking, number 38 about the employee integrity selection system, number 39 about the company's business ethics guidelines, number 40 about whistle blowing policy, Number 41 on Supplier Contract Terms, Number 45 on Control action by the Social System, and Number 50 on Emergency Response Plans show that PT A and PT B have a low level of vulnerability. This shows that the supervisory factors in the two companies in terms of information systems, employee integrity, business ethics, whistle blowing policies, supplier contract terms, social systems, and emergency response plans have been well mitigated. As such, companies can continue to focus on mitigating risks around these aspects by implementing best practices (Soon et al., 2019).

As for number 48 on law enforcement in the local supply chain, it can be seen that both companies have a moderate level of vulnerability. This shows that the two companies are in the supply chain with state laws that do not burden companies such as the provision of incentives and tax relief. This also indicates that the legal conditions in the local supply chain do not pose a significant obstacle, however, companies need to remain vigilant and ensure compliance with applicable regulations (Usman et al., 2021). In number 31 about the difference in the price of raw materials and final products due to state regulations, number 32 concerning the control action of raw materials, number 33 concerning verification of control action in raw materials, number 34 concerning control action food fraud In the final product, number 35 concerning control action food fraud In the final product, number 37 about the tracking and tracing system, number 42 about the control action system on suppliers, number 43 about the control action of the raw material balance system on suppliers, number 44 about the control action of the balance system on raw materials, number 47 about the state food policy, and number 49 about law enforcement, it can be seen that PT B has a low level of vulnerability and PT A has a medium level of vulnerability so that the second level of vulnerability The company is different. This happens because in PT B all these aspects have been well mitigated because the company is able to channel resources in these aspects. PT B shows a low level of vulnerability in most aspects of the supply chain and suppliers, while PT A has a moderate level of vulnerability in a number of indicators. This difference may be due to PT B's ability to channel resources to manage these aspects. PT A needs to consider increasing control

action in several aspects to reduce potential risks (Yang et al., 2022). Meanwhile, in number 46 about the effectiveness of control action food fraud It can be seen that PT B has a low level of vulnerability, while PT A also has a low level of vulnerability. This shows that both companies have been able to understand in more detail the impact of state regulations on the difference in the price of raw materials with the final product and take appropriate measures.

Based on the results of the spider web above, it can be emphasized that by focusing attention on strengthening control action, legal compliance, and supply chain integrity, PT A and PT B can increase the level of readiness and reduce vulnerability to potential risks. The implementation of these recommendations can help create a safer and more sustainable business environment for both companies. Some of the recommendations for improvement such as PT A and PT B can involve employees in regular training related to business ethics, whistle blowing principles, and emergency response procedures. This can help build a better company culture. The application of advanced technology in the control action of information systems and employee integrity can also be implemented to help reduce the risk of information leakage and fraud by employees. Increased internal controls and audits are also needed. In addition, both companies can conduct an in-depth analysis related to the impact of state regulations on the difference in the price of raw materials and final products. This involves further understanding the tax rules and incentives that can affect price dynamics.

**Key Factors of Food Fraud Vulnerability**

Based on the results of data processing collected from respondents in both companies, the results of the combined mapping of opportunity, motivation, and control action factors in Figures 4, 5, and 6 show the main factors of food fraud vulnerability in both companies.

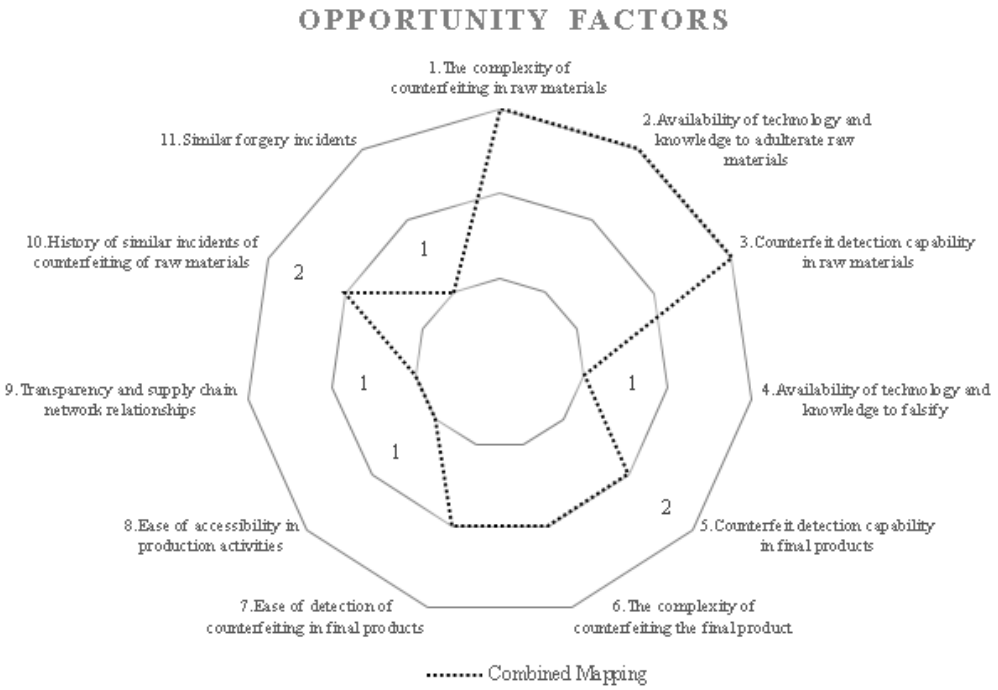


**Figure 4.** Combined mapping of opportunity factors in both companies

It is known that indicators that have are the main vulnerability to food fraud The second opportunity factor of the company is on indicator number 1 about the complexity of doing food fraud In materials, number 2 is about technology and knowledge related to raw materials, number 3 is about the ability to detect contamination of raw materials, number 6 is about the complexity of counterfeiting final products, and number 7 is about the ability to counterfeit final products. Some of these indicators are the main vulnerabilities because the two companies have not been able to close the path food fraud of some of these indicators to the maximum. Meanwhile, other indicators are not included in the main

vulnerability because both companies are able to mitigate risks in a preventive and repressive way. In indicator number 1, companies need to review the complexity of the raw materials used. Efforts to diversify raw material sources and select materials that are easier to verify can help reduce risks food fraud (Silvis et al., 2017). For indicator number 2, there is a need for investment in technology that can improve monitoring and knowledge related to raw materials. The implementation of sensor technology, technology-based tracking systems, and the integration of artificial intelligence solutions can help improve detection capabilities and minimize risks (Barrere et al., 2020).

As for responding to the high vulnerability of indicator number 3, both companies must improve their ability to detect contamination in raw materials by strengthening quality test methods and advanced detection technology. Regular audits on suppliers can also help ensure the cleanliness of raw materials. As for indicators number 6 and 7, PT A and PT B must improve security measures at the final production stage, including the application of anti-counterfeiting technology and a special verification system for the final product. The involvement of authorities and forensic experts can support preventive and detection measures.

Comprehensively, it appears that both companies need to evaluate and prioritize handling of key vulnerabilities in the food fraud, both companies can develop more effective strategies to protect their supply chains. Increased technology, surveillance, and collaboration will be key to reducing risk and improving product safety. There are several ways that can be taken, such as increasing security measures at the final production stage, including the application of anti-counterfeiting technology and a special verification system for the final product. The involvement of authorities and forensic experts can support preventive and detection measures (Huisman & van Ruth, 2022).

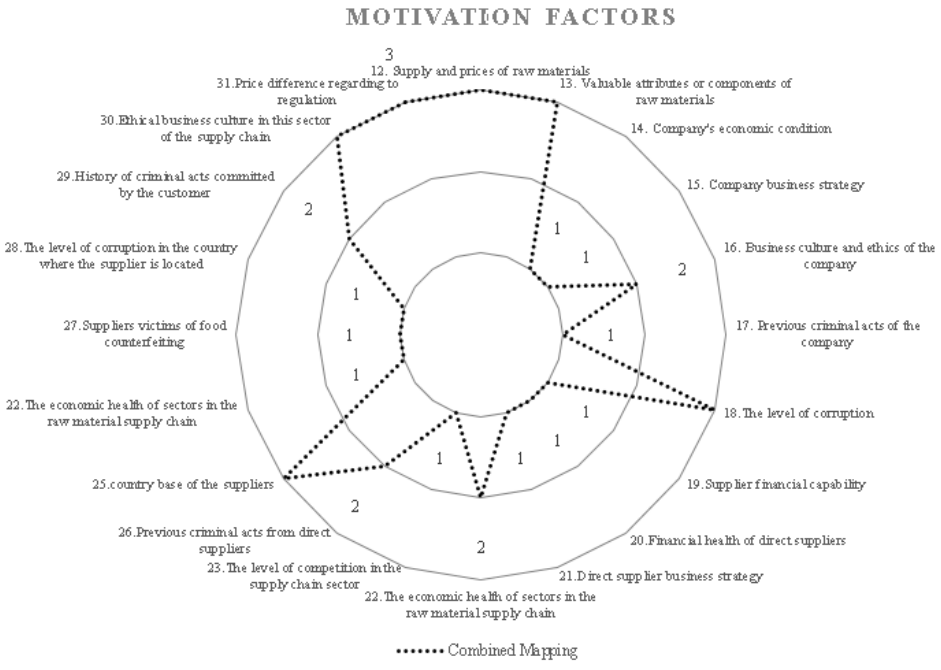


**Figure 5.** Combined mapping of motivational factors in both companies

It is known that the indicators that have become the main vulnerability to food fraud in the motivational factors of the two companies are indicator number 12 about the supply of raw material prices, number 13 about special attributes that determine the value of raw materials, number 18 about the level of state corruption, number 25 about the economic condition of the supply chain, and number 30 about the level of industrial competition. This happens because both companies have not been able to prevent food fraud from the aspect of human resources from internal and external aspects. As for other indicators, they are not included in the main vulnerability because both companies are able to minimize the motivation for food fraud in this aspect. As an improvement effort, in indicator number 12, companies need to understand more about the role of raw material prices in food fraud motivation.

Measures can involve supplier diversification, stricter contract negotiations, and constant monitoring of fluctuations in raw material prices. For indicator number 13, further work can be done on the special attributes of raw materials need to be done. An in-depth understanding of the values that determine the price of raw materials can help companies identify potential food fraud risks and take appropriate action. As for indicator number 18, identification can be carried out by reducing the risk of corruption in the supply chain, especially at the country level. This can involve cooperation with government agencies and involvement in anti-corruption initiatives. For indicator number 25, both companies can involve economic research in the supply chain to understand the financial condition of suppliers and other business partners. Companies need to mitigate the risk of food fraud by understanding economic dynamics along the supply chain. As for indicator number 30, strategic steps can be taken, such as industry cooperation or mutual awareness campaigns, which can help reduce risks in the context of competition.

Based on the combined analysis of the motivational factors above, it can be seen that both companies can design more effective strategies to address the motivation underlying the action. A focus on prevention from human resources, economic analysis, and collaboration with external parties can help reduce risk and maintain supply chain security (Soon et al., 2019). Some actions that can be taken such as prevention food fraud from the aspect of human resources. This involves increased oversight, employee training, and the implementation of policies that support integrity and compliance. In addition, collaboration with external parties, such as security agencies and independent auditors, can help monitor and assess compliance and integrity in the supply chain.

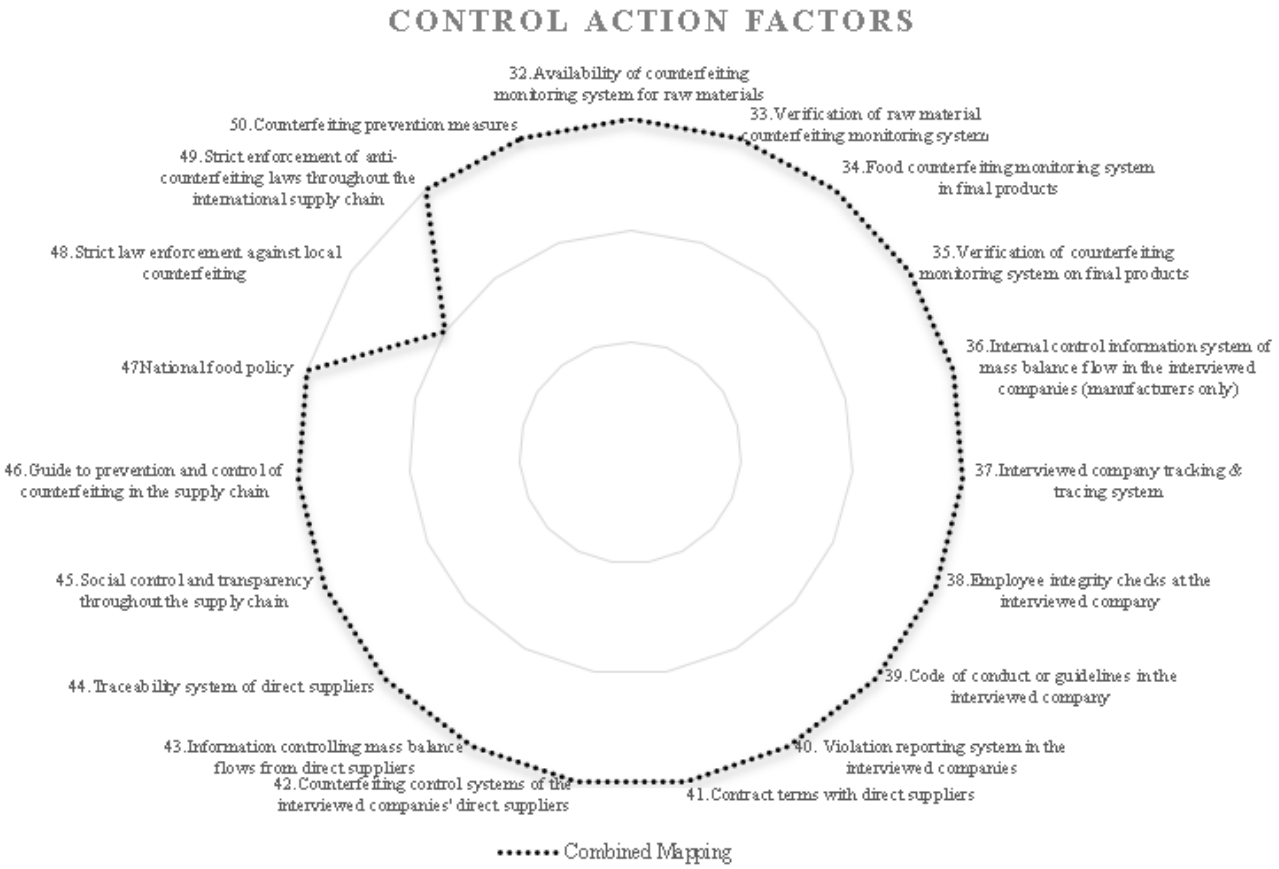


**Figure 6.** Combined mapping of control action factors in both companies

It is known that indicators that are vulnerable are low food fraud The supervisory factors of the two companies are in all indicators except number 48 concerning law enforcement in the supply chain. This shows that in the supply chain ecosystem, both suppliers and companies have not been able to fully

comply with applicable regulations and laws (Lord et al., 2022). Meanwhile, all other indicators show that the two companies have been able to increase control action both internally and externally regarding these aspects. This shows that both companies have been able to mitigate the surveillance factor because they have a low level of vulnerability.

**Simple Correspondence Analysis (SCA)**

To test and describe the communication relationship between the two companies, the Simple Correspondence Analysis (SCA) test will be used with the help of SPSS software as follows

***Correspondence Graph***

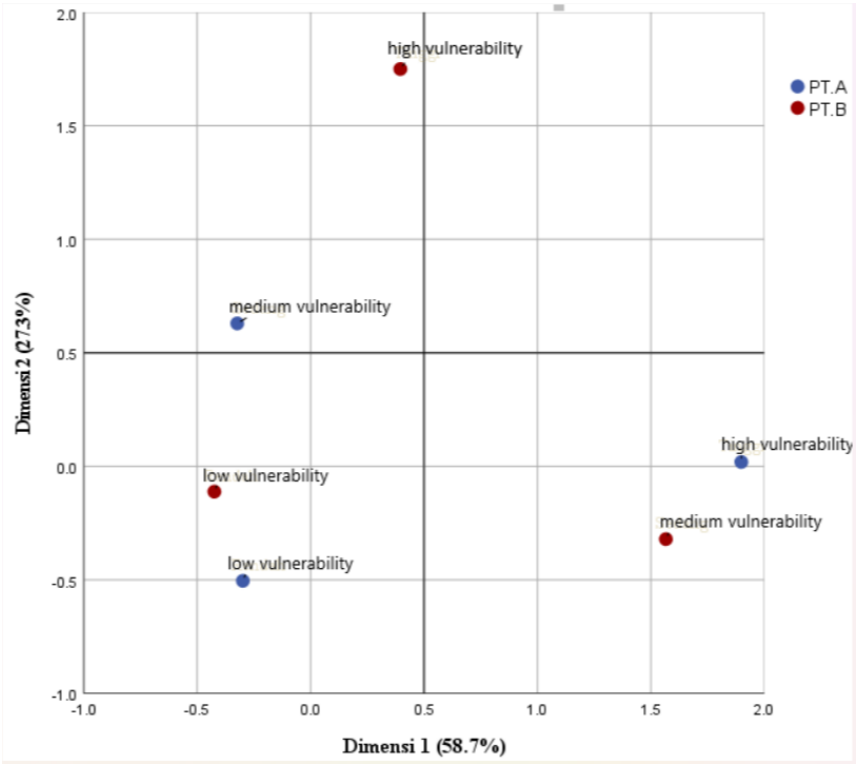


**Figure 7.** Correspondence Graph Results

To determine the correspondence relationship of the graph, it can be seen from the coordinate points and adjacent positions and on the same quadrant a point is located. Based on the graph above, it can be seen that in quadrant 1 there are no indicators located in the quadrant. For quadrant 2, there are indicators that are in the medium category from PT A and high in PT B which explain that the indicators are in the same quadrant so that it explains that the two categories of indicators are likely to correspond with each other. Meanwhile, indicators that are categorized as medium in PT A have a close relationship with the low category in PT B quadrant 3. Meanwhile, in quadrant 3 itself, there is a low category of PT A and a low category of PT B, this explains that there is a relationship between the two categories because the conditions experienced by PT A are likely to also occur in PT B such as external factors, namely corruption in Indonesia, lack of transparency in the supply chain, to policies that apply in Indonesia related to the spice production industry. As for quadrant 4, there is a high category from PT A and a medium category from PT B, this explains that the indicator that shows a high level of vulnerability in PT A does not have the same level of vulnerability as PT B because it is still in the medium vulnerability category. This shows that every indicator that is categorized as high vulnerability in PT A will also result in a medium category in PT B so that it is known that PT B is able to mitigate the existence of food fraud in this indicator. This can also happen because of different internal factors of the company

such as work culture, technology quality, to the complexity of raw materials which are the internal domain of each company so that they have different levels of vulnerability. Thus, the analysis of the position of the quadrants on the chart provides an overview of the relationship between the categories of indicators in the two companies. Quadrants 2 and 4 show the potential impact of external and internal factors that can affect the level of vulnerability to food fraud.

**Chi-Square Test Results**

**Table 4.** Chi Square Test Results

| Chi-Square Tests | | | |
|---|---|---|---|
| | ***Value*** | ***df*** | ***Asymptotic Significance (2-sided)*** |
| Pearson Chi-Square | 31.520a | 4 | .000 |
| Likelihood Ratio | 38.357 | 4 | .000 |
| Linear-by-Linear Association | 18.680 | 1 | .000 |
| N of Valid Cases | 50 | | |
| a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 2.70. | | | |

Based on the above results, If the calculated Chi-Square value is greater than the p-value (p-value <0.05), then H0 is rejected, indicating a significant difference between companies, conversely, if the p-value ≥ 0.05, H0 is accepted, indicating there is insufficient evidence to state a difference (Baker & Kelleher 2002). Based on the results in table 5, the Chi-Square Test significance value is 0.000 <0.05 so that it can be stated that H0 is rejected and Ha is accepted. Thus, it can be stated that there is a difference in food fraud vulnerability between the two companies. This confirms that there is a significant difference between food fraud vulnerability in PT A and PT B. PT B shows a lower level of vulnerability compared to PT A. This shows that PT B has implemented better practices in product quality management and control action, thereby reducing the risk of food fraud. PT B's better performance can be caused by stricter policies in terms of internal audits, employee training on food safety, and a more effective control action system.

**CONCLUSION**

The analysis of food fraud vulnerability in this study, using the SSAFE Food Fraud Vulnerability Assessment Tool, examines three key factors: opportunity, motivation, and control action. The study, conducted on two spice industry companies, PT A and PT B, reveals that PT A has higher vulnerability in opportunity factors, while PT B has higher vulnerability in motivation indicators. PT B also shows better internal control, leading to lower overall vulnerability compared to PT A. External factors like corruption, supply chains, and economic conditions contribute similarly to vulnerability in both companies, highlighting their significant impact. Internal factors, such as company control systems and employee management, differ between the companies, with PT B demonstrating stronger controls. To improve food fraud handling strategies, it is recommended that PT A strengthen its internal controls, while PT B should focus on deeper analysis and proactive prevention of motivational factors. Future research should explore the role of technology, such as blockchain, in enhancing supply chain transparency and reducing food fraud vulnerability.

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