Strategies Management of The Production Loss Risk Control In The Food Crop Cultivation System

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Abstract. This research aims to identify factors that cause the risk of production loss, analyze the main risk, and analyze alternative strategies for controlling the risk of production loss in the edamame food commodity cultivation system. The sampling method was Simple Random Sampling, and the sample size was 32 respondents. The respondents in this study were edamame farmers. The data collected is primary data and secondary data. This research uses FMEA and AHP analysis for data processing. The results of this research conclude that in edamame cultivation, there are main factors as sources of risk, namely plan, source, make, and delivery factors that cause production loss. There are 5 main risk levels of production loss in edamame cultivation based on the RPN critical value, namely grading process (291.92), raw material procurement (274.07), production process (273.07), production control (267 .23), and raw material supplies (265.16) as well as obtaining a strategy to control the risk of production loss in edamame cultivation, namely using grading process criteria to increase production and make efforts to improve postharvest handling so that edamame production can be maximized.

Keywords: Risk of Loss, Production, Edamame Cultivation

1 Introduction

One of the developing businesses in Indonesia is the food commodity business (Kusuma, 2007). Business in the food sector is one of the business sectors that plays a very important role in the Indonesian economy. This business can meet Indonesia's food needs and generate foreign exchange. Businesses in this field can also reduce unemployment or absorb many workers and encourage the establishment of supporting industries such as agricultural equipment, agricultural inputs, food additives, packaging, and machinery and food processing equipment industries.

Every business activity or business carried out will always have risks and uncertainties. This is contrary to the behavior of individuals who usually always want certainty in their business activities. The magnitude of the existing risks is usually directly proportional to the benefits or advantages we will obtain. Risks in business activities can be measured from the indicators obtained, such as variations or fluctuations in production capacity, prices, or income obtained by decision-makers. So, decision-makers need to assess the level of risk in their business to determine risk control strategies to reduce risk.

The agricultural sector is a sector that plays a very important role in supporting community welfare. The agricultural commodities in Indonesia with the highest demand are food commodities such as rice, corn, sweet potatoes, cassava, peanuts, green beans, and soybeans. Soybeans are a food crop commodity whose demand is quite high, both for direct consumption and as processed ingredients for the food industry. The average soybean production on a national scale in 2020 was 613,300 tons. This production is insufficient for domestic needs, so imports of 2,475,286 tons are needed (BPS, 2021).KEdamame, which is very popular and beneficial for body health, is edamame (green soybean vegetable), which has the scientific name Glycine max (L) Merr. Fresh edamame is also a food ingredient (Kaiser

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and Ernst, 2020).

Risk control strategy management is very important in the edamame cultivation system because one of the processes that greatly influences edamame production results is the postharvest handling of edamame. Postharvest handling includes all processes or steps, from planting edamame soybeans to the final consumer, including handling raw materials, storage, transportation, distribution, and marketing. Postharvest handling aims to maintain fresh quality, ensure the safety of plant commodities used as food, and meet buyer specifications and trade requirements. Additionally, crop losses often occur, resulting in losses (Serrana and Rolle, 2018).

Factors influencing risk control over crop loss, or the edamame production process consist of external and internal factors. External factors include mechanical damage caused by poor handling, inappropriate packaging during transportation, bruising on the pods, cuts, breaks, wounds, and other physical damage, including damage caused by parasites such as fungi, bacteria, insects, etc. Other things that cause the source to lose production results. Internal factors are caused by physiological damage because edamame still carries out physiological activities that can ultimately cause damage after harvesting. Losses in the field also occur due to untimely harvesting, poor harvesting operations, careless handling, and natural disasters such as heavy rain, birds, rodents, etc. (Dutta et al., 2013). Therefore, managing risk control strategies in the edamame cultivation system is necessary to minimize production loss. Risk management can be carried out in several stages, such as risk identification, risk assessment, development of control strategies, implementation of actions, monitoring, and reporting.

The main objective of risk control management is to minimize the negative impact of risks that can affect the achievement of a business or project. In the edamame cultivation system, the most critical risks that require serious attention are loss of production during harvest and pest and disease attacks on plants, which are difficult to detect and have serious impacts. So, strategic management is needed to control the risk of production loss in edamame cultivation. The line of thinking in this research explains the problems to be studied supported by theory and previous research related to identifying sources of production risk in edamame soybeans.

This study aims to identify factors that cause production losses in the edamame cultivation system. In addition, this paper attempts to analyze the main risk levels in handling edamame production using fishbone diagrams and FMEA analysis. Likewise, alternative strategies for controlling the risk of production loss in edamame cultivation is also analyzed.

2 Literature Review

2.1 Risk Control Strategy Management

Risk control strategic management is a systematic and planned approach to identifying, assessing, managing, and minimizing business or enterprise performance achievement risks. This activity involves developing and implementing strategies designed to control risk in a manner that is effective and appropriate to the business performance to be achieved. Risk control strategy management can be formulated in several stages, such as risk identification, risk assessment, development of control strategies, implementation of control measures, regular monitoring and assessment, the commitment of businesspeople and partners, and transparency and reporting (Wibowo et al., 2020).

Risk identification can be done by identifying potential risks that may be faced in carrying out business. This can include financial, operational, strategic, compliance, reputation risks, etc. Risk assessment evaluates risks to determine how much they can affect business performance. This involves assessing the severity and probability of the risk occurring. Developing a control strategy requires developing an appropriate risk control strategy to manage the risks that have been identified (Suryaningrat, 2019). Risk control strategy management is an important element of overall management in a business. The aim is to help businesses or businesses achieve business performance in a safer and more focused way,

2.2 Internal and External Factors Causing Production Risk

According to Ramnah et al. (2022), External factors include mechanical damage caused by poor handling, inappropriate packaging during transportation, bruising on the pods, cuts, breaks, injuries, and other physical damage, including damage caused by parasites (parasitic diseases), such as fungi, bacteria, insects, etc. which cause postharvest losses. Meanwhile,

internal factors are caused by physiological damage, whereas edamame is a vegetable that, after being harvested, still carries out physiological activities, which, in the end, can cause damage.

2.3 Identify sources of Production Risk

Risk is the potential for adverse events caused by uncertainty regarding the occurrence of an event (Yasa et al., 2013). Risk identification is an analysis process to systematically and continuously discover potential loss risks that challenge the company (Hsu et al., 2015). Internal factors are humans, methods, management, and materials. Meanwhile, external factors are the environment surrounding production. According to the source, there are two risks, namely financial risk and non-financial risk, which is a risk that arises due to the failure of internal processes, systems, technology, and external factors (Syamsiah et al., 2019).

Fishbone diagrams are a useful method for finding the root cause of problems in a user-friendly manner, which is liked by manufacturing people because the process has a variety of variables that have the potential to cause problems to arise (Purba et al., 2020)

2.4 Production Risk Control Strategy

Risk control (mitigation) strategies are actions that will be taken to address potential risks that arise, including avoiding risk, transferring risk, mitigating risk, and accepting risk. Risk control alternatives include activities to control risks, create mitigation measures, reduce the impact of risks, and reduce the likelihood of a risk occurring. So that this stage produces a risk action strategy that will be implemented to reduce/mitigate the risk of re-emergence (Sherlywati, 2018).

3 Data and Methodology

3.1 Data

This research is a survey with a sample size of 32 respondents from the population of edamame commodity farmers in Megamendung Village, Bogor. Primary data was obtained through field observations and interviews with respondents. Secondary data was obtained from libraries and scientific publications. Determining respondents using the purposive sampling method,

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3.2 Data Analysis

The analysis used by the author in this research is descriptive and quantitative. The data obtained in the research is grouped based on type, namely FMEA analysis with measurement parameters, namely detection, the severity of risk effects (Severity), and frequency of risk-causing events (Occurrence). In risk measurement, the process includes identifying the source of the risk of loss of edamame production, identification of the causes of risk (fishbone diagram) and the amount of risk obtained from calculating the critical value of RPN, analysis of the risk of loss of production (FMEA analysis or Failure Mode and Impact Analysis with parameters namely Detection, Severity, and Occurrence. The scale of these parameters is 1-10, respectively, Risk Priority Number (RPN) and Developing risk control using the AHP method.

The RPN value is known by multiplying the severity, occurrence, and detection parameters with the lowest value 1 and the highest 1000. The formula for the RPN value and critical RPN value is as follows:

$$\text{RPN Critical Value} = \frac{\text{Total RPN}}{\text{Amount of Risk}}$$

$$\text{RPN} = (\text{Severity}) \times (\text{Occurrence}) \times (\text{Detection})$$

4 Result and Findings

4.1 Result

Identify Sources of Risk for Edamame Soybean Production

The edamame production process in edamame cultivation starts from the land preparation stage to postharvest. In production, internal factors source the risk of physiological damage

because edamame still carries out physiological activities that can ultimately cause damage after harvesting. Based on the complex cultivation stages, it is necessary to identify potential sources of risk for edamame soybean production to minimize loss of edamame control production. Based on the research results, there are four risk factors for loss of edamame production.

Planning Factors (Plan)

Planning factors in the edamame cultivation system include preparing cultivation activities from the land processing stage to postharvest. Land preparation planning is important because it will affect crop yields—plan for raw materials such as quality (certified) seeds. The advantages of quality seeds are that they reduce the risk of cultivation failure because they can grow well in less favorable land conditions, have higher production, and are resistant to pest and disease attacks. Calculation planning: 1kg of edamame seeds can produce 70 kg of edamame soybeans. Pest and disease prevention planning in edamame cultivation still uses inorganic insecticides.

Procurement Factors (Source)

Procurement factors to prepare tools and materials for cultivating edamame. Edamame seeds are used seeds from edamame that are harvested over 80 days and dried or bought online at e-commerce. The quality of these seeds is not guaranteed, affecting edamame soybeans' production.

Production Process Factors (Make)

Production process factors influence the growth and development of edamame plants to produce edamame soybeans. You must pay attention to the planting schedule when planting edamame because the climate or weather influences it. Edamame can be cultivated throughout the year. In the rainy season, edamame growth decreases due to the lack of sunlight intensity, and the duration of photosynthesis is reduced so that the harvest time is longer, namely 70 HTS. Irrigation for edamame is with sufficient water conditions. Care and maintenance of edamame is carried out periodically, and insecticide spraying is also carried out to prevent pests and diseases.

Shipping Factors (Delivery)

Harvested edamame contains green seeds, 1, 2, and 3 seeds in one pod and is unaffected by pests. Postharvest (primary processing) starts by washing the edamame with clean water in a holding pond and draining it—the sorting or grading stage for edamame, which has 2 and 3 seeds for Rp12,000 sent to the supermarket and for 1 seed edamame and small pods for Rp8,000 were sent to traditional markets. The plastic packaging measures 1 kg and 10 kg, and the sacks measure 25 kg and 50 kg.

Identify the Causes of the Risk of Production Loss

The causes of the risk of loss of edamame production are identified as a cause and effect diagram (fishbone diagram). The causes of the risk of loss of edamame production are grouped based on factors at the source of the risk of loss, including plan, source, make, and delivery. Risk grouping aims to determine the causes of risk for each group and the impact of each risk cause, which is an obstacle to cultivating edamame soybeans.A brand's image is a perception that is created through time, is largely consistent, and lasts a long period. Therefore, the Service Quality received by consumers will have an impact on brand image, if the service quality is good, then the brand image will also be good.

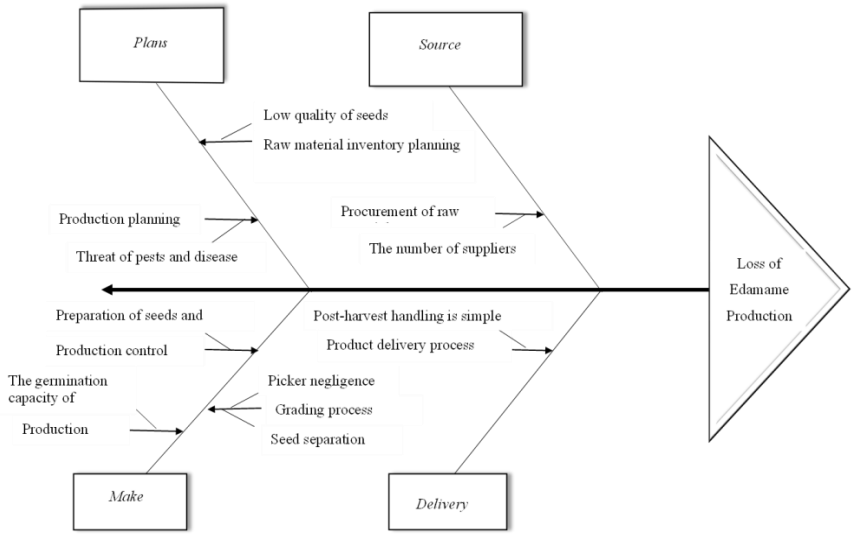

Fig 1. *Fishbone Diagram*

Analysis of the Risk of Loss of Edamame Production

The results of the risk analysis of production loss on the fishbone diagram and analysis of the causes of critical risks using the FMEA (Failure mode and effect analysis) method or failure mode and impact analysis aim to identify and assess risks related to potential failure. Information on the risk of loss of edamame production is in the following table 1.

Table 1. Mark*Severity, Occurrence, Detection, and RPN*

No	Factor Risk	Reason Risk	Value			RPN	*Priorities*
			Severity	*Occurrence*	*Detection*		
1	Plans	Supply Raw material	5.79	6.96	6.58	265.16	5
2		Planning Production	4.00	6.65	6.40	170.24	6
3	Source	Procurement Raw material	6.58	6.33	6.58	274.07	2
4		Process Production	6.73	6.12	6.63	273.07	3
5	Make	Control Production	6.21	6.54	6.58	267.23	4
6		Process *Grading*	7.00	6.29	6.63	291.92	1
7	Delivery	Process Delivery Product	5.14	5.21	5.43	145.41	7

The table 1 shows that the severity, occurrence, and detection values for the causes of risk of production loss in the grading process with RPN are 291.92 (medium category), and efforts are needed to correct the causes of risk. The result of multiplying the RPN value shows the seriousness of the potential failure; the higher the RPN risk value, the more problematic it is, and vice versa.

Table 2. Critical Value Causes Risk of Loss of Edamame Production

Priority	Causes of Risk	RPN	Critical value	Information
5	Raw Material Inventory	265.16		Critical
6	Production Planning	170.13		Not Critical
2	Procurement of Raw Materials	274.21		Critical
3	Production process	272.87	241,014	Critical
4	Production Control	267.30		Critical
1	Grading Process	291.70		Critical
7	Product Delivery Process	145.41		Not critical

Risk mitigation is planned and sustainable action from the causes of risks that have a critical RPN value to reduce the impact of an event that has the potential or could be detrimental to production activities in the edamame cultivation system. Preparing risk mitigation proposals begins with analyzing the causes of risks through a fishbone diagram. Proposing mitigation by addressing the sources of risk that cause the risk to occur. Suggestions for mitigating the risk of loss of edamame production:

Table 3. Proposed Mitigation of the Risk of Loss of Edamame Production

No	Causes of Risk	Risk Consequences	Risk Mitigation
1	Raw material inventory	The germination capacity of edamame seeds is low	Improved seed quality
2	Procurement of raw materials	The number of suppliers is limited	
3	Production process	Threat of pests and disease	Edamame pest and disease control
			Carrying out process checks
4	Production control	Preparation of seeds and fertilizer	Land sterilization
5	Grading process	Picker negligence	Training in improving human resources
		Seed separation 3,2,1	Improved postharvest handling

Suggestions for mitigating the risk of loss of edamame production can be identified from the criteria factors. *Analytic Hierarchy Process* (AHP) and risk mitigation are alternative proposals for evaluating efforts to improve the edamame cultivation system. Risks that require mitigation and risk management measures are at the avoid risk level, starting from risks with the highest RPN value to the lowest.

Strategy for Controlling the Risk of Losing Edamame Production

The strategy for controlling the risk of loss of edamame production is determined hierarchically, including criteria, objectives, and alternatives. Criteria are the factors that cause the risk of critical production loss. Objectives are the proposed control objectives proposed to control the causes of the risk, and alternative or proposed mitigation is a choice of strategies that can be used to control the risk. The hierarchical structure of risk control for edamame production losses is shown in the following figure.

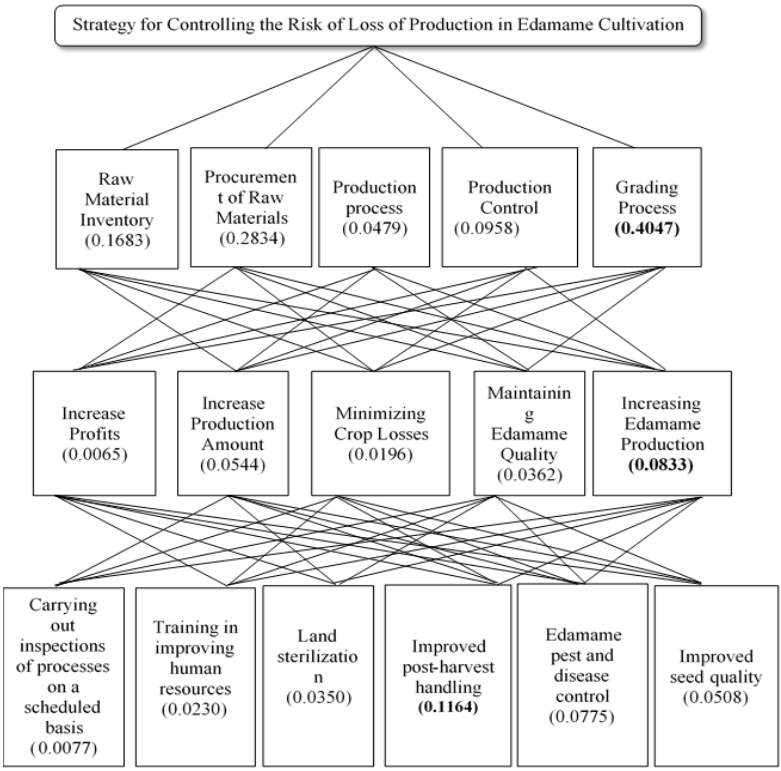

Fig 2.Hierarchical Structure for Controlling the Risk of Edamame Production Losses

The production risk control strategy for edamame cultivation has the main criteria or priority in the grading process with several (0.4047). The grading process criteria are the critical factors most at risk. Postharvest technology is divided into two activities: primary postharvest and secondary postharvest. Primary postharvest activities include harvesting, collecting, threshing/milling/stripping, washing, sorting, grading, transportation, drying, milling and/or flouring, packaging, storage and distribution, and transportation. Secondary postharvest includes processing fresh products into processed products, either intermediate or semi-finished products or finished products. The quality of agricultural products is closely related to applying postharvest facilities and technology.

Based on the research results, the most appropriate strategy in controlling the risk of production loss in edamame cultivation is increasing postharvest handling by an amount of (0.1164). Postharvest handling of horticultural products, generally consumed fresh and perishable, aims to maintain their fresh condition and prevent undesirable changes during storage.

4.2 Findings

Identify Sources of Risk for Edamame Soybean Production

In the production process, some factors influence production losses when harvesting edamame, including external and internal factors. Internal factors are caused by physiological damage because edamame still carries out physiological activities that can ultimately cause damage after harvesting. External factors include mechanical damage caused by poor handling, inappropriate packaging during transportation, bruising on the pods, cuts, breaks, injuries, and other physical damage, including damage caused by parasites (Wibowo et al., 2020). The results show that the sources of risk of loss of edamame production are four main factors, including.

Planning Factors (Plan)

Planning factors influence edamame cultivation, from the preparation of cultivation activities from the land processing stage to postharvest. Land preparation planning is important to do because it will affect crop yields. The most important planning for raw materials in edamame cultivation is the quality of the edamame seeds. Quality seeds anticipate the risk of cultivation failure because the seeds can grow well in less favorable land conditions, have higher production, and are resistant to pest and disease attacks (Septiani et al., 2022). Calculation planning: 1kg of edamame seeds can produce 70 kg. KEdamame soybeans can be harvested for up to two harvests, but the quality decreases as the seeds in the pods become small and production yields decrease (Hayati, 2022).

Procurement Factors (Source)

Procurement factors are needed to prepare tools and materials for cultivating edamame. Edamame seeds use self-produced seeds from edamame that are harvested over 80 days and dried or bought online at e-commerce. The quality of these seeds is not guaranteed, thus affecting the production of edamame soybeans.

Production Process Factors (Make)

Production process factors influence the growth and development of edamame plants so that production is optimal. Edamame can be cultivated throughout the year, but in the rainy season, edamame growth decreases due to the lack of sunlight intensity, so the plant's photosynthesis process decreases so that the harvest time is longer, namely at 70 HTS. Pests that attack edamame plants are white butterflies (hoppers), leafroller caterpillars, and black ladybirds, which cause a decrease in production. Losses caused by pest attacks can include plant damage, plant death, significant reduction in yield, and even crop failure. OPT control efforts can use superior varieties.

Shipping Factors (Delivery)

The edamame that is harvested is edamame that contains seeds, is green, contains 1, 2, and 3 seeds in one pod, and is not affected by pests. Postharvest (primary processing) starts by washing the edamame with clean water in a holding pond and draining it. The sorting or grading stage for edamame, which has 2 and 3 seeds for Rp12,000 was sent to the supermarket for 1 seed edamame, and small pods at Rp8,000 were sent to traditional markets. The plastic packaging used is 1 kg and 10 kg, and the sacks are 25 kg and 50 kg.

Traditional harvesting involves determining a harvest time of 65 days observing environmental conditions, physical equipment, and plant physiological characteristics (Rigo et al., 2020).

Identify the Causes of the Risk of Production Loss

The risk of production loss is identified (fishbone diagram). The causes of risk of loss of edamame production are grouped: plan, source, make, and delivery. Risk grouping aims to determine the causes of risk from each group and the impact of each risk cause, which is an obstacle to edamame cultivation. Fishbone Diagrams identify possible causes of a problem (Septiani et al., 2022). It can be seen that there are seven causes of risk, namely raw material planning, production planning, raw material procurement, production control, production process, grading process, and product delivery process (Fishbone Diagram).

Analysis of the Risk of Losing Edamame Production

The severity, occurrence, and detection values causing the risk of production loss are classified as high. Namely, in the grading process, the RPN value is 291.92, which is in the medium category with priority, and efforts are needed to correct the causes of the risk. The multiplication result for the RPN value shows the level of seriousness. Potential failure: The higher the RPN risk value, the more problematic or higher the level of criticality of a system, and vice versa, the lower the RPN risk value, the lower the level of criticality of the system (Kartika et al., 2021).

According to Marpaung (2017), determining critical conditions can be done by looking for the critical RPN value, which is the result of comparing the total RPN value with the number of potential risk causes. Based on the value results, it can be seen that the factors that are

classified as critical are the grading process (291.70), raw material procurement (274.21), production process (272.87), production control (267.30), and raw material inventory (265, 16). These factors need serious attention, and control efforts need to be made. Critical conditions are conditions that have a major influence on the quality of a product (Syafira et al., 2022).

Mitigation proposals Risks that require mitigation and risk management measures are risks at the avoid risk level, starting from risks with the highest RPN value to the lowest. Risk management is an effort made to reduce the impact it causes when a risk occurs, while risk mitigation is an effort to reduce the impact and/or opportunity for a risk to occur (Annisa et al., 2021).

Strategy for Controlling the Risk of Losing Edamame Production

The production risk control strategy in edamame cultivation has priorities that must be considered to control risks in the grading process with the amount (0.4047). The grading process criteria are the main critical factors that are most at risk of production loss in edamame cultivation based on the results of FMEA critical value calculations. The quality of agricultural products is closely related to applying postharvest facilities and technology. Most postharvest handling still uses simple (traditional) technological means. This low use of facilities and technology is caused by the low quality of human resources and the lack of availability of postharvest facilities and technology in rural areas. Weak development of postharvest handling contributes to the low quality of the products produced, which directly impacts the low competitiveness of products in both domestic and international markets. Grading is carried out based on weight, size, shape or appearance, color, and freedom from disease and other defects. This sorting can be done manually based on the sense of sight and hands (Awanis et al., 2022).

It is important to increase postharvest handling by the amount (0.1164). Postharvest handling of horticultural products is very important because the products are generally consumed fresh and perishable. The horticultural postharvest handling system involves everything from harvesting to the consumer or processing unit (Rosmawaty et al., 2020).

5 Conclusion

A brand's image is a perception that is created through time, is largely consistent, and lasts a long period. Therefore, the Service Quality received by consumers will have an impact on brand image, if the service quality is good, then the brand image will also be good.

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5.1 Conclusion

In edamame cultivation, there are 4 main factors as sources of risk, namely plan, source, make, and delivery factors, which cause loss of production. In the fishbone and FMEA diagram analysis, there are 5 main risk levels of production loss in edamame cultivation based on the RPN critical value, namely grading (291.92), raw material procurement (274.07), production process (273.07), production control (267, 23), and raw material inventory (265.16).

5.2 Policy implication

The strategy for controlling the risk of production loss in edamame cultivation is by using grading process criteria to increase production and make efforts to improve postharvest handling so that edamame production can be maximized.

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