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Risk Mitigation Strategy in the Supply Chain of Soil Blocks as an Environmentally Friendly Horticultural Seedling Medium

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ABSTRACT

Soil blocks serve as a solution to reduce plastic waste and soil degradation caused by conventional seedling media. This product offers an environmentally friendly alternative to horticultural seedling media by utilising waste sediment from Lake Rawa Pening and organic biomass such as chicken manure and cocopeat. However, the supply chain management of this product still faces various potential risks that require appropriate risk management strategies. This study aims to analyse the supply chain mechanism of soil blocks and design a risk mitigation framework using the House of Risk (HoR) method. A case study approach was employed, involving the mapping of the supply chain process based on the Supply Chain Operation Reference (SCOR) model, followed by a risk analysis conducted in two HoR phases. The study was conducted from January to April 2025 at Akar Kreasi Nuswantara, a pioneer in soil block production in Wonosobo Regency. Both descriptive and quantitative data analysis methods were used. Data were collected through interviews and questionnaires involving six key informants from the company and analysed using ARP (Aggregate Risk Potential), TEk (Effectiveness of Mitigation Strategy), Dk (Difficulty of Implementation), and ETDk (Effectiveness Times Difficulty). The study identified 24 risk events and 17 risk agents, with five top priorities: raw material access disruption, lead time for material readiness, limited supplier availability, delays in product collection by consumers, and obstacles in returning wooden trays. Recommended mitigation strategies include buffer stock management, long-term partnerships, standard operating procedures (SOPs) for production, digital reminder systems, and return incentives for wooden trays.

INTRODUCTION

Agribusiness development opportunities present strategic challenges that require systematic thinking and risk analysis-based implementation. Agribusiness is a series of economic activities in the agricultural sector that encompasses activities from upstream to downstream, including the provision of production inputs, cultivation processes, product processing, distribution, and marketing. This scope makes it vulnerable to various forms of complex and interrelated risks. Supply chain disruptions, climate change, dependence on external inputs, and regulatory uncertainty are the main sources of risk in agribusiness that impact production and distribution stability (Imbiri *et al.,* 2021; Mooney, 2015; Broka *et al.,* 2016). Effective supply chain risk management is key to maintaining the sustainability and competitiveness of agribusiness amid global dynamics (Imbiri *et al.,* 2021). These risks require integrated management to prevent declines in business performance and sustainability.

Agribusiness performance is influenced by the effectiveness of supply chain management in coordinating the flow of products, information, and financing. Supply Chain Management (SCM) provides a framework for identifying distribution disruptions and facilitating data-driven decision-making through risk mapping. The House of Risk (HoR) method enables the identification of relationships between events and risk agents, as well as the prioritization of mitigation based on severity and probability. The integration of SCM and HoR strengthens the adaptive capacity for agribusiness in the face of uncertainty. This application is crucial for managing risks in sediment waste-based soil block agribusiness, given its dependence on environmental factors. This study aims to analyse the soil block supply chain mechanism and design a risk-mitigation framework using the House of Risk (HoR) method. A case study approach was used, involving supply chain process mapping based on the Supply Chain Operations Reference (SCOR) model, followed by risk analysis through two HoR phases.

Soil blocks are cube-shaped growing media developed as an environmentally friendly alternative to plastic or topsoil, utilizing sediments from Lake Rawa Pening. This innovation addresses the environmental issues caused by non-biodegradable plastic waste, which poses toxicity risks to organisms and disrupts soil ecosystem functions (Pandey *et al.,* 2022). The soil blocks consist of a mixture of Lake Rawa Pening sediment, chicken manure, cocopeat, dolomite lime, natural phosphate, and water. According to research, soil blocks can boost phosphorus and organic matter content, increase productivity by over 90%, and lower global warming potential by 48% when compared to polybags (Pertiwi *et al.,* 2025). Excessive exploitation of topsoil has a negative impact on the environment through a reduction in land capacity and damage to ecological functions (Sprunger, 2023). Soil blocks based on sediments from Lake Rawa Pening were developed by Eka Mardiana and produced by Akar Kreasi Nuswantara in Wonosobo. Akar Kreasi Nuswantara is a pioneer in developing sediment-based soil blocks from Lake Rawa Pening and consistently promotes sustainable agricultural innovation and circular economy practices. It also stands as the only field-scale-applied producer of lake -sediment soil blocks, making it a highly relevant and significant subject for this study.

Several studies on risk management have been conducted, including those by Solikha and Marodiyah (2024), which employed Quality Risk Management (QRM) and Failure Mode Effect Criticality Analysis (FMECA) methods. In addition, the House of Risk method has been applied in agribusiness risk analyses by Marchello *et al.* (2023), Ulfah (2022), Rozudin and Mahbubah (2021) & Adhiana and Sibarani (2020). However, studies on the supply chain of planting media or soil block products remains limited. These products are good for the environment, but require a strong supply chain to succeed. An efficient and sustainable supply chain ensures the reliable availability of raw materials, effective production processes, and timely distribution to end users (Harya *et al.,* 2020). Many green farming projects have problems with their supply chains, which affect both the environment and economy. The objective of this study is to analyse supply chain risks associated with sediment-based soil blocks from Lake Rawa Pening. Therefore, the novelty of this study lies in assessing the risks that emerge when waste materials, particularly lake sediment, are used as production inputs for containerless planting media. By analysing how sediment is transformed into soil blocks and the unique upstream risks it creates, this study extends HoR applications toward non-conventional waste-based inputs and fills a gap in agribusiness risk research within circular production systems.

METHODS

The research method employed in this study is a case study approach that focuses on the risk analysis of the supply chain of sediment-based soil blocks from Lake Rawa Pening. The research was conducted from January to April 2025. The research location was determined purposively to be around Lake Rawa Pening as the main source of raw materials (sediment) and in Wonosobo Regency as the production location of the Akar Kreasi Nuswantara company. The data consisted of both primary and secondary sources. Primary data were obtained through direct observation of supply chain activities and interviews using questionnaires with key informants, including sediment suppliers, sediment intermediaries, and internal company personnel specialising in each production activity. Secondary data were collected from internal company documentation and relevant literature.

This study employed a judgment sampling technique, in which respondents were selected based on their knowledge, position, and direct involvement in the soil block supply chain. The method was selected to ensure alignment with the objectives researched and to collect appropriate information or problems (Imran, 2017). In total, six key informants participated in the study: the company founder, operations director, operations manager, field division coordinator, partnership division coordinator, and nursery division coordinator. Although the number of informants was limited, purposive selection ensured that all participants possessed direct operational experience and specialized knowledge relevant to the soil block supply chain. This aligns with expert-based approaches such as HoR, where depth of expertise is prioritized over the sample size. The data collection method was carried out through observation and in-depth interviews to identify risk events and risk agents and to evaluate the supply chain system as a basis for designing risk mitigation using the House of Risk (HoR) approach.

This research was conducted by a structured framework that was developed to include steps and principles for identifying, analysing, evaluating risks, and planning mitigation strategies in the company's supply chain. The supply chain processes were mapped using the Supply Chain Operations Reference (SCOR) model, which consists of five main stages: plan, source, make, deliver, and return. The severity, occurrence, and correlation values were determined using expert judgment based on structured qualitative indicators adapted from Shahin (2004) and Syamsiah *et al.* (2019). These references provide the conceptual foundation for measuring the magnitude of impact (severity), likelihood of a risk source occurring (occurrence), and the strength of the correlation between a risk agent and a risk event, as well as the correlation between a risk agent and a risk-mitigation action. These scales were operationalized using Likert-type categories that guide experts in assigning scores consistently.

A. Risk Event and Risk Agent Analysis

The first calculation step begins with mapping the supply chain process using the SCOR model as the basis for analysis. The SCOR method can objectively map the supply chain process based on existing data and identifies areas requiring improvements.

B. Analysis of House of Risk Phase 1 Results

Once the severity, frequency, and correlation values are determined, the next step is to calculate the Aggregate Risk Potential (ARP) value. The ARP values were obtained by multiplying the severity, frequency, and correlation values. If severity (Si) indicates the severity of the impact if risk event i occurs, occurrence (Oc) is the probability or frequency of risk source event j, and Rij is the correlation between risk source j and risk event i, then ARPj (Aggregate Risk Potential of the risk source) can be calculated using the following formula:

$$ARP_j = O_c \Sigma S_i \times R_{ij}$$

C. Risk Agent Priority Analysis Using Pareto Diagrams

Once all ARP values have been obtained, the next step is to prioritize the risk agents to obtain the cumulative ARP percentage. By utilizing Pareto diagrams, the risk agents that will be prioritized and mitigated in the House of Risk Phase 2 can be identified.

D. Mitigation Action Design Analysis (Prevention Action)

The planning of risk-mitigation actions is carried out only for priority risk agents selected through the Pareto diagram. These mitigation actions were obtained through discussions with the operational director of Akar Kreasi Nuswantara. After the mitigation actions are identified, the next step is to determine the degree of difficulty in implementing them (Dk) using a scale of 3, 4, and 5. A score of 3 indicates that implementation is easy, 4 indicates that implementation is quite difficult, and 5 indicates that implementation is difficult.

E. Analysis of House of Risk Phase 2 Results

Determining the results in the second phase of the House of Risk method begins with identifying the level of correlation between mitigation actions and priority risk sources, followed by calculating the Total Effectiveness (TEk) and Expected Total Difficulty (ETDk) values. There were three levels of correlation values: 1, 3, and 9, while 0 represents no correlation. The numbers 1, 3, and 9 indicate low, moderate, and strong correlations, respectively. These correlation values were determined based on experts' discussions with the operational director of Akar Kreasi Nuswantara. After obtaining the correlation values, the TEk value was calculated. The formula for the TEk value is as follOws:

$$TE = ARP \times E$$

After the TEk value is known, the next step is to calculate the total effectiveness ratio or Effectiveness to Difficulty Ratio (ETDk). The formula for calculating the ETDk is as follows:

$$ETDk = TEk / Dk$$

Based on the ETDk value, the ranking of mitigation actions can be determined from the highest to the lowest values.

RESULTS AND DISCUSSION

Identification of Soil Block Supply Chain Risk Events

A risk event refers to any incident or condition that has the potential to disrupt the smooth running of the Akar Kreasi Nuswantara supply chain. Each identified event is evaluated based on its severity using a rating scale of 1 to 10 to describe its potential impact on the overall performance of the supply chain.

Based on Table 1, the highest risk is found in code E7 in the source process, namely, the inability to purchase soil block manufacturing materials. This event has a total average score of six, which falls into the moderate category or has a moderate effect, indicating a decline in quality but still within tolerable limits and can still be handled quite well by the company. However, this risk event still requires special attention because it can cause delays in the production process, increased operational costs, and disruptions in meeting the market demand. The inability to obtain soil block-making materials in a timely manner can be a weakness in the supply chain that directly affects the operational stability of the company. The second-highest average risk event is coded E12 in the process, referring to the unmet production quantity target with a score of 5.33. This score falls into a significant category or has a low impact that may cause inconvenience to consumers and producers. Although the

Table 1. Identification of Soil Block Risk Events

Process Element	Identification of Risk Event	Code	Severity Score
Plan	Errors in planning materials for soil block production	E1	2.17
	Insufficiently prepared production facilities	E2	1.67
	Errors in forecasting soil block production volumes	E3	1.50
	Disrupted cash flow	E4	1.33
	Volatile and unpredictable market demand	E5	1.33
Source	Lack of capital for ordering/procuring raw materials	E6	1.33
	Inability to purchase raw materials for soil block productions	E7	6.00
	Declining or non-standard quality of raw materials for soil block production	E8	3.17
Make	Soil blocks damaged during the seedling process	E9	1.50
	Soil block making equipment failure	E10	1.67
	Stockpiling due to overproduction of soil blocks	E11	1.00
	Production quantity targets not achieved	E12	5.33
	Number of market players	E13	1.00
	Soil block quality not in accordance with SOP	E14	3.00
	Poor cleanliness/ hygiene during production	E15	1.00
	Insufficient labour during production	E16	1.33
	Errors in administrative input	E17	1.33
	Accumulation of residual materials and pollution of the surrounding environment	E18	1.00
	Underutilized production capacity (under capacity)	E19	4.50
Deliver	Product pickup not at the agreed time / Product not picked up at the agreed time.	E20	5.00
	Quality degradation during transportation	E21	2.67
	Late delivery	E22	1.83
	Limited number of wooden trays for storing soil blocks	E23	4.33
Return	Complaints from customers	E24	2.67

Source: Processed Primary Data (2025)

effect is low, this risk event still needs to be anticipated because it can cause a mismatch between production output and market demand. Failure to achieve production quantity targets can cause backlogs or a pileup of unfulfilled orders, a decline in customer satisfaction, and an increased workload in the next production period. In addition, the disruption can affect overall operational efficiency and distribution planning.

The lowest-severity risks, each with a score of 1.00, are associated with codes E11, E13, E15, and E18, which relate to stockpiling, the number of business actors, production process hygiene, and environmental pollution due to material residues. These risks have the lowest average severity scores, indicating that their potential impact on overall supply chain performance is relatively minor compared to other identified risks. Although they should not be ignored, their influence tends to be limited and can be mitigated through routine operational improvements and adherence to standard procedures. Continuous monitoring and preventive measures are recommended to ensure that these low-severity risks do not escalate under changing production or environmental conditions.

Identification of Soil Block Supply Chain Risk Agents

A risk agent is an event that has the potential to cause a risk event. The risk agents of the soil block supply chain from Lake Rawa Pening sediments at Akar Kreasi Nuswantara are assessed based on occurrence frequency on a scale of 1-10. The results are presented in Table 2.

Based on Table 2, there are 17 risk agent classifications in Akar Kreasi Nuswantara. The results show that the highest occurrence score is possessed by risk agents with code A8, namely blooming water hyacinth and the rainy season, which limits access to resource extraction, with an average score of 5.83. The lowest occurrence score, with an average value of 1.00, is with code A5 or unskilled labour, A15 or an increase in the number of business actors and industries, and A17 or the absence of SOPs for managing production waste. These risks exhibit the lowest likelihood of occurrence, suggesting that they emerge infrequently under current operational conditions. Although their probability is low, they

Table 2. Identification of Soil Block Risk Agents

Identification of Risk Agent	Code	Occurrence
Blooming water hyacinth and the rainy season limiting access	A8	5.83
Waiting time for soil block materials to become ready for use	A9	5.67
Limited availability of soil block materials and the number of suppliers	A1	5.33
Consumers failing to pick up soil blocks according to the agreed schedule	A13	4.00
Wooden trays not returned or quickly becoming mouldy	A11	3.17
Lack of structured production SOPs	A2	2.17
No soil block stock available for sudden orders	A16	2.00
Rising incidence of pests and diseases	A10	1.67
Late payment by consumers	A14	1.67
Lack of a standard administrative system	A3	1.50
Absence of systematic procedures for maintaining production machinery	A4	1.50
Access roads to soil block delivery sites are difficult to traverse	A12	1.50
Insufficient monitoring of product quality	A6	1.33
Inaccurate and poorly structured production process planning	A7	1.17
Unskilled labour	A5	1.00
Growing number of businesses and industries	A15	1.00
Absence of SOPs for production waste management	A17	1.00

Source: Processed Primary Data (2025)

still require attention to prevent potential disruptions, particularly because changes in workforce dynamics, industry competition, or waste management practices can increase their likelihood. Regular supervision, capacity building, and procedural reinforcement are recommended to ensure that these low -occurrence risks remain controlled and do not develop into significant issues.

House of Risk Phase 1 Analysis

Risk indicators for the soil block supply chain at Akar Kreasi Nuswantara were identified using severity and occurrence values, which were then used to assess the relationship between risk agents and risk events in the form of correlations to be entered into the HoR Phase 1 matrix. HoR Phase 1 is the process of identifying and prioritizing risk events based on the Aggregate Risk Potential (ARP) value.

Based on Table 3, the ranking of existing risk agents can be determined through the calculation of Aggregate Risk Priority (ARP). The ARP value indicates the order of danger for risk agents, which must be addressed immediately based on a priority scale. The higher the ARP value, the more dangerous the risk agent is and the more urgent it is to address it. The determination of risk agent priorities can be presented using a Pareto chart.

Based on Figure 1, five risk agents are prioritized based on the ARP values presented in the Pareto diagram. This prioritization is based on the Pareto principle (80:20 rule), which states that approximately 80% of problems or risk events are usually caused by 20% of the total causes or risk agents. The cumulative curve (orange) shows that the first five risk agents cover more than 80% of the total existing risks. Harlan and Syela (2024) stated that this approach provides an analytical basis for researchers to focus

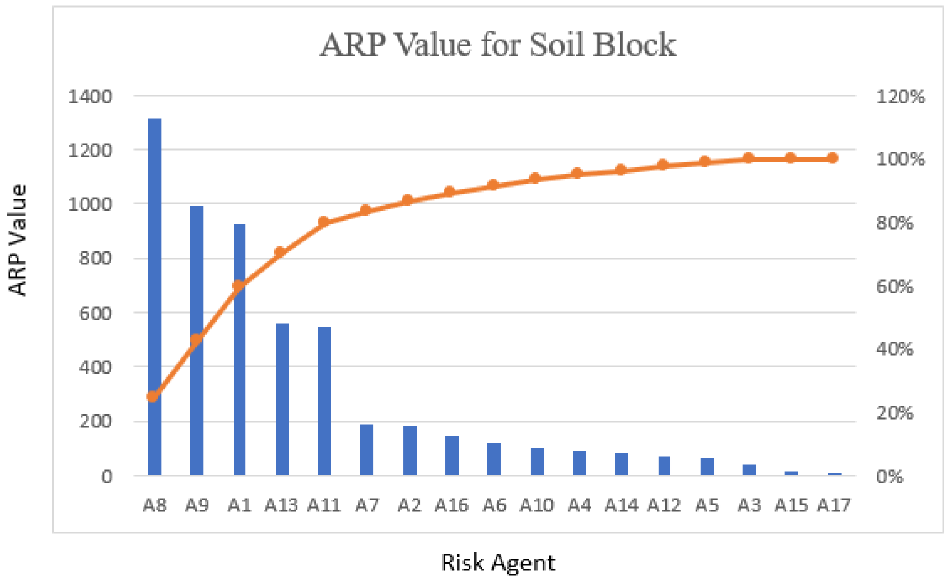

Figure 1. Pareto Chart of ARP Values for Soil Blocks
Source: Processed Primary Data (2025)

Table 3. House of Risk Phase 1 Analysis

Risk Event	*Risk Agent*																	
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	Si
E1	1	1	1	1	1	1	9	9	1							1		2.17
E2		3	1	3							1							1.67
E3	3	1	1	1	3		9	9	9		1		3					1.50
E4	1	1	1					1	1	9	3	1	9	9				1.33
E5											1				3			1.33
E6	1										3		9	3				1.33
E7	9							9	9		3		3	3		1		6.00
E8		3				9	1	9	1		1							3.17
E9		9			3		1		1	9	1							1.50
E10		1		9	3		1				1							1.67
E11		1	1		1		1						1					1.00
E12	9	1		3	3		9	9	9		3							5.33
E13													1		9			1.00
E14	1	9	1	1	3	9	1	1	1	9	1		3					3.00
E15		1				1					1		1					1.00
E16					9													1.33
E17			9		1						1		1					1.33
E18		1				1					3		1				9	1.00
E19	9	1		3	1	1	9	9	9		3				1	9		4.50
E20											9	3	9					5.00
E21												3	1					2.67
E22	9				1			3			3	9	9	1				1.83
E23							1	1			9		3	3				4.33
E24	1	3	1	1	1	9	9	3	3	3	3	3	1			9		2.67
Oc	5.33	2.17	1.50	1.50	1.00	1.33	1.17	5.83	5.67	1.67	3.17	1.50	4.00	1.67	1.00	2.00	1.00	
ARP	928	179	38	88	65	117	187	1319	993	101	546	73	563	82	18	145	9	
Rank	3	7	15	11	14	9	6	1	2	10	5	13	4	12	16	8	17	

Source: Processed Primary Data (2025)

Table 4. Soil Block Risk Agent Priorities

Risk Agent	Code	ARP Score
Blooming water hyacinth and the rainy season limiting access	A8	5.83
Waiting time for soil block materials to become ready for use	A9	5.67
Limited availability of soil block materials and the number of suppliers	A1	5.33
Consumers failing to pick up soil blocks according to the agreed schedule	A13	4.00
Wooden trays not returned or quickly becoming mouldy	A11	3.17

Source: Processed Primary Data (2025)

their attention on a small number of risk agents that contribute most significantly to the occurrence of risks. Thus, identifying these 20% of major risk agents is expected to address up to 80% of procurement problems more effectively and efficiently. The Pareto diagram in Figure 1 illustrates that the higher the ARP value, the higher the priority and level of danger posed by the risk. Conversely, the risk agents on the right side of the Pareto diagram have lower ARP values, indicating that the potential impact and urgency of handling them are relatively lower. Based on Table 4, the highest-ranked risk agent with an ARP value of 1,318.55 is coded A8, referring to water hyacinth blooming and the rainy season, which limits access. One of the main ingredients for making soil blocks is sediment from Lake Rawa Pening, which is rich in organic matter, making it a suitable seedling medium. The rainy season is closely correlated with water hyacinth blooming, which affects the sediment collection. Increased rainfall causes the lake's water volume to rise, triggering massive growth and the spread of the water hyacinth. This is in line with the findings of Karnelasatri et al. (2020), who stated that increased rainfall raises the lake's water volume and accelerates the growth of the water hyacinth owing to nutrient runoff, such as nitrogen and phosphorus. This massive growth covers the lake surface and hinders access to sediment collection points. As a result, sediment transportation by boat becomes difficult because propellers are prone to being caught in water hyacinths and strong winds. This condition directly affects the availability of raw materials and increases the risk of disruption of the soil block supply chain in Akar Kreasi Nuswantara.

The rainy season not only hinders the sediment collection process but also poses challenges in the post-production stage of soil blocks. High air humidity and rainfall create environmental conditions that promote fungal growth, both in trays and soil blocks containing seedlings. Damp trays tend to mold more quickly and can become a medium for spreading pathogens and decay easily, resulting in limited stock and additional costs for repurchasing. Seedlings in soil blocks are more susceptible to disease and are detrimental to the company. This is in line with the f of Hussain et al. (2020), who stated that high humidity during the rainy season facilitates the growth of fungal pathogens, such as Fusarium poae, Alternaria tenuis, and Aspergillus niger, which can cause significant damage to plant seeds. These conditions not only reduce the quality and success rate of seedlings but also impact on production efficiency and the trust of farmer users.

The second-priority risk factor was the waiting time required for soil block materials to be ready for use with code A9, which had an ARP value of 993.19. This risk reflects the potential for disruptions in the supply chain due to the need to mature and dry materials such as sediment, cocopeat, and chicken manure before use. This delay has a significant impact on the continuity of production and must be optimally managed to avoid losses and disruption in the supply chain. Sediment must be dried naturally for 3-7 days to reduce the water content with a storage procedure that prevents cross-contamination to maintain the quality. Cocopeat requires storage for approximately two weeks while chicken manure requires one week to reach maturity. This maturation process is important for improving the quality of soil block-making materials. This is in line with the findings of Lebrun et al. (2023), who stated that the maturation of chicken manure can increase microbial diversity and nutrient availability. Maitra and Zaman (2017) added that the maturation of cocopeat increases water retention capacity and aeration, which are important for plant root growth. The third-priority risk agent with an ARP value of 928.00 is coded A1, referring to the limited availability of soil block manufacturing materials and the number of suppliers. This risk agent indicates a high dependence on a small number of suppliers for the provision of key raw materials such as sediment. This limited number of suppliers reduces flexibility in procurement and increases the likelihood of disruptions if one supplier experiences problems, such as delivery delays, sediment stock shortage, decline in material quality, or price fluctuations. In addition, this condition can prolong procurement time and cause irregularities in production flow. This is in line with the findings of Jadhav and Prakash (2024), who state that a limited number of raw material suppliers are very dangerous because they pose various significant challenges to the sustainability of the company's supply chain, such as production delays, increased costs, and inefficiencies.

The fourth risk agent priority is that consumers do not pick soil blocks according to the previously agreed schedule, coded A13 which has an ARP value of 565.67. This risk agent has a detrimental impact on operations because it is directly related to the efficiency of seedling bed usage and the company's workload. When consumers delay collection, soil blocks that already contain seedlings must be managed and maintained at production sites. Consequently, the space that must be used for the next production cycle is blocked. This delay not only disrupts the next production schedule but also incurs additional maintenance costs that must be borne by the company, such as daily watering, pest and disease control, and additional labour to monitor the condition of the seedlings. In the long term, this condition risks reducing seedling quality owing to environmental stress or prolonged retention in the seedling medium, which can ultimately affect customer satisfaction and the company's overall image.

The final priority is wooden trays that are not returned by consumers or quickly become mouldy, with code A13 having an ARP value of 545.77. As end consumers, farmers are not obliged to return trays. However, they are still encouraged to do so as a form of participation in maintaining sustainable production and minimizing unnecessary waste. The obligation to return wooden trays after use applies only to corporate or institutional consumers. The data obtained show that the tray return rate from companies reaches approximately 90%, whereas that from farmers is only approximately 10%. The low return rate, especially from farmers, results in losses for Akar Kreasi Nuswantara because the unit price of wooden trays is IDR 7,000. If not managed properly, this can increase operational costs owing to the need to continuously purchase new trays. In addition, trays that mould quickly shorten the useful life of the material, particularly when stored under humid conditions or used during the rainy season.

House of Risk Phase 2 Analysis

The priority risk agents presented in HoR Phase 1 were then used as a reference for inputting the analysis material into HoR Phase 2. HoR Phase 2 was used to determine the priority level of effective actions needed to address the risk agents. Following Pedekawati et al. (2017), management strategies were obtained based on the results of interviews with informants. Five main management strategies were identified to address the supply chain risks that may arise. The risk-management strategies are listed in Table 5.0

Based on Table 5, five management strategies can be implemented at Akar Kreasi Nuswantara to overcome supply chain risks. These strategies were then incorporated into the HoR Phase 2 matrix to assess the correlation between risk agents and the mitigation strategies using a scale of 0, 1, 3, and 9. The level of difficulty in implementing mitigation strategies was then determined using a scale of 3, 4, and 5.

Table 5. Soil Block Supply Chain Risk Management Strategy

Strategy	Code
Develop and disseminate standardized SOPs for production, maintenance, and administration	PA1
Establish long-term partnerships with soil block raw material suppliers to ensure sustainable supply	PA2
Maintain buffer stocks of soil block materials or place early orders, especially during the dry season	PA3
Implement reminder systems for product pick-up schedules via WhatsApp or phone to reduce delays	PA4
Implement a rental system or provide incentives for returning wooden trays, along with applying anti-fungal coating treatments	PA5

Source: Processed Primary Data (2025)

Table 6. House of Risk Phase 2 Analysis

Risk Agent	Management Strategy					
	PA1	PA2	PA3	PA4	PA5	ARP
A8	1	9	9			1775.24
A9	1	9	9			1104.71
A1	3	9	9			956.444
A13	3			9		562.667
A11	3			1	9	545.768
TeK	9,074.58	34,527.46	34,527.46	5,609.77	4,911.91	
DK	4	5	4	3	4	
ETD	2,268.64	6,905.49	8,631.86	1,869.92	1,227.98	
Rank	3	2	1	4	5	

Source: Processed Primary Data (2025)

The HoR Phase 2 matrix produces a ranking of mitigation strategies that are the most appropriate and efficient to implement. The strategy that obtains the highest Effectiveness to Difficulty Ratio (ETD) score is prioritized for implementation first, as it is considered to have a large mitigation impact on the main risk with a relatively low level of implementation difficulty. The results of the assessment and analysis using the Phase 2 HoR matrix are shown in Table 6.

Based on Table 6a priority raking for each management strategy can be identified. This ranking or order of priority shows which management strategy is the most effective for the risk agents. Risk management strategies were ranked based on ETD ratings, as presented in Table 7.

Table 7 shows that the ranking of strategies that should be prioritized for efficient supply chain risk mitigation is based on the Effectiveness to Difficulty (ETD) value. The ranking was sorted from highest to lowest. The highest ETD value is found in code PA3, which involves buffering the stock of soil block-making materials or ordering

Table 7. Soil Block Risk Strategy Priorities

Strategy	Code	ETD Score
Maintain buffer stocks of soil block materials or place early orders, especially during the dry season	PA3	8,631.86
Establish long-term partnerships with soil block raw material suppliers to ensure sustainable supply	PA2	6,805.49
Develop and disseminate standardized SOPs for production, maintenance, and administration	PA1	2,268.64
Implement reminder systems for product pick-up schedules via WhatsApp or phone to reduce delays	PA4	1,869.92
Implement a rental system or provide incentives for returning wooden trays, along with applying anti-fungal coating treatments	PA5	1,227.98

Source: Processed Primary Data (2025)

early, especially during the dry season, with an ETD value of 8,631.86. In contrast, the lowest ranking is in code PA5, which involves implementing a rental system or providing incentives for the return of wooden trays and antifungal coating treatment, with an ETD value of 1,227.98.

The strategy of building buffer stock or conducting early procurement of soil block-making materials, particularly during the dry season, ranked first with an ETD value of 8,631.86. These findings indicate that maintaining buffer stocks and implementing early procurement are practical and highly effective strategies for small agribusinesses that rely on seasonal raw materials. For enterprises such as Akar Kreasi Nuswantara, establishing structured reorder points and minimum stock thresholds for key inputs can help ensure continuous production and prevent operational disruptions. This approach allows managers to anticipate fluctuations in raw material availability and secure supplies before shortages occur. Whenever the stock approaches this minimum limit, the company can immediately place an order or reorder so that supplies never depleted during production. The buffer stock method helps predict raw material requirements based on incoming orders, thereby reducing the risk of stock shortages during production. Qadafi and Wahyudi (2020) noted that the buffer stock method has several advantages, including minimizing production risks related to raw material shortages and accommodating large order quantities.

Small agribusinesses operating under strong seasonal constraints can benefit significantly from scheduling early procurement based on projected demand and seasonal patterns. By purchasing larger quantities of raw materials at the beginning of the dry season, companies can stabilize production schedules, avoid weather-related delays, and reduce their exposure to price volatility. This approach is particularly important for producers that depend on sediment from Lake Rawa Pening, because access to this material becomes more difficult during the rainy season. Maron *et al.* (2024) highlight that early procurement helps minimize the risk of price fluctuations because securing raw materials earlier reduces the maximum risk associated with monthly price variability. Ensuring the stable availability of inputs allows the production process to continue without disruption, maintains consistent product delivery, and enhances customer satisfaction. Overall, this strategy strengthens supply chain resilience and supports reliable operational performance for small agribusinesses.

The development of long-term cooperation with suppliers of soil block raw materials ranked second, with an ETD value of 6,805.49. This shows that a solid and mutually beneficial relationship between the company and suppliers is crucial for maintaining the stability of the supply of key raw materials, such as sediment, chicken manure, cocopeat, natural phosphate, and dolomite limestone. Such long-term partnerships help small agribusinesses reduce major supply chain risks, especially delivery delays, inconsistent material quality, and weak supplier responsiveness during sudden demand or seasonal changes. Enhancing coordination, trust, and flexibility within these relationships enables managers to secure more dependable raw materials, maintain smoother production flows, and minimize disruptions that could threaten business continuity. Jadhav and Prakash (2024) emphasized that companies should also be able to diversify their supplier base to reduce dependence on a limited number of suppliers so that the continuity of the supply chain is not disrupted.

Developing more detailed SOPs for production, maintenance, and administration along with disseminating these SOPs to consumers is the third risk mitigation priority, with an ETD value of 2,268.64. Strengthening SOPs in this way provides small agribusinesses with clearer operational guidelines, supports more consistent product quality, and helps consumers use soil blocks correctly, thereby reducing the likelihood of errors or performance issues across the supply chain. With detailed SOPs that are effectively disseminated, the company can organize the collection and return of wooden trays in a more orderly manner, thereby increasing tray turnover and reducing the risk of a shortage of trays for seedling media. In addition, the problem of consumers not picking up soil blocks according to the agreed schedule can also be minimized through written guidelines that clarify the rights and obligations of each party. Rahmawati and Suryana (2024) added that SOPs provide clear instructions that minimize confusion and losses during the entire pre-production, production, and post-production processes. The implementation of these SOPs plays a major role in maintaining the smooth flow of product distribution and return and supports logistics efficiency in the Akar Kreasi Nuswantara supply chain system as a whole.

The implementation of a product pickup schedule reminder system via WhatsApp or telephone is the fourth risk mitigation priority, with an ETD value of 1,869.92, as it effectively encourages consumers to pick up soil blocks on time, as agreed. Timely pickups help maintain a smooth distribution flow, prevent product accumulation in the warehouse, and ensure that storage capacity remains available for subsequent production cycles. Improving the order-pickup process also reduces bottlenecks in the distribution area and strengthens overall operational performance, particularly because order picking is one of the most labour-intensive activities in small agribusiness operations. Streamlined order picking also increases accuracy, prevents product buildup, and supports smoother warehouse operations, ultimately improving overall supply chain performance (Deshpande & Kumar, 2020).

The last mitigation priority involves a rental system or incentives for returning wooden trays along with anti-fungal coating treatment, has an ETD value of 1,227.98. This strategy aims to increase the return rate of trays in usable conditions. The implementation of a rental system for wooden trays, supported by return incentives and antifungal coating treatment, enhances operational efficiency by increasing the return rate of trays in usable conditions, reducing replacement costs, and extending their service life. This approach also accelerates the turnover of essential production tools and maintains a consistent tray availability, thereby preventing disruptions caused by shortages or delays. By incentivizing returns and applying antifungal coatings, the company further strengthens durability and cost efficiency, which are especially important in high-demand environments.

CONCLUSION AND SUGGESTION

Based on the results of this study, the sediment-based soil block supply chain at Akar Kreasi Nuswantara is characterized by several upstream and operational risks arising from seasonal fluctuations, raw material dependency, and consumer behaviour. The analysis showed that transforming lake sediment into soil blocks creates risk patterns that differ from conventional agribusiness inputs, with distinct exposures to environmental constraints, supplier concentration, and post-production handling challenges. The HoR Phase 1 analysis identified five priority risk agents, while Phase 2 produced five corresponding mitigation strategies, reflecting the need for integrated actions, such as inventory planning, strengthened supplier collaboration, standardized operational procedures, consumer coordination, and tray-return mechanisms. These findings provide practical insights into improving the resilience and managerial effectiveness of small agribusinesses operating within circular and environmentally oriented production systems.

This study contributes to agribusiness supply chain risk management by extending the use of the House of Risk (HoR) to non-conventional inputs, such as sediment-based soil blocks, and demonstrating its integration with the SCOR model to capture complementary process- and risk-oriented perspectives. The combined framework also provides practical value for small agribusinesses, demonstrating that supply resilience can be improved through structured buffer-stock systems, long-term supplier cooperation, clear operational SOPs, and simple digital reminders to enhance customer pickup compliance. These insights offer guidance for practitioners and policymakers in strengthening community-based agribusiness operations and supporting circular agricultural initiatives. Despite their value, the findings remain limited to one organization and rely on the perspectives of selected informants. Future research may expand the analysis to multiple companies or regions to strengthen generalizability. It may also incorporate probabilistic methods such as Monte Carlo Simulation or System Dynamics to quantify risks more comprehensively through expected values (EV), variances, percentiles, and worst-case scenarios, thereby offering more robust insights for effective mitigation strategies in supply chain risk management.

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