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RISK MANAGEMENT OF RAW MATERIAL PROCUREMENT IN MADUKISMO SUGAR FACTORY WITH THE HOUSE OF RISK METHOD

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ABSTRACT

Procurement of raw materials and sugarcane processing into sugar is an important part of the supply chain, which has the potential for various risks. Therefore, efforts are needed to gradually and continuously improve supply chain performance to overcome and prevent various risks. This research aims to (1) identify risk events and risk agents, (2) analyze risk agents that need to be prioritized for preventive action and (3) determine risk mitigation priorities in the procurement of sugar raw materials at the Madukismo Sugar Factory. The research method used is a descriptive case study method. Determining the criteria for risk events in the business process uses the Supply Chain Operation Reference (SCOR) dimensions. Risk agents and risk mitigation are analyzed using the House of Risk (HOR) method which consists of two phases. Based on the research results, 14 priority risk agents were found. Risk mitigation to address priority risk agents ranked 1-5 is: reformulating the SOP for cultivating seed sugarcane and milled sugarcane specific on Madukismo Sugar Factory, carrying out HR training, providing funds and production facilities on time, disciplining the implementation of SOPs through reward and punishment, and increasing supervision by each Plant Section personnel.

Keywords: *House of Risk (HOR), risk management, sugarcane*

BACKGROUND

Sugar production in Indonesia has fluctuated throughout history. In the 1930s, Indonesia was once the second largest sugar exporting country globally, mainly due to its abundant sugar production from sugar cane. However, along with political, social, and economic changes and other factors such as technology and market demand, Indonesia's sugar industry underwent significant changes (Hariadi et al., 2016). In 2021, Indonesia became the world's second-largest sugar-importing country after the United States. Rapid population growth and changing consumption patterns have increased the demand for sugar in Indonesia. Dependence on sugar imports can also be affected by domestic production factors, such as erratic weather and other factors that affect agricultural output (Arief & Sofyan, 2021).

Over the last few years, national sugar production has not been able to meet people's needs. The importance of granulated sugar for the Indonesian population comes from the government's statement that it is the only one of the two basic building materials (staple food) that the general public must consume. As a result of the need for the government to pay close attention to ensure that the public can access the fair and accessible availability of granulated sugar at a sufficiently high price, this situation has had very unfavorable and unintended consequences. But as it is, sugar production

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in the country is becoming less and less, and sugar imports are increasing at an alarming rate due to the increasing public demand for sugar (Sutanto & Muljaningsih, 2022)

Sugar, especially granulated sugar, is produced from sugar cane plants (*Saccharum Officinarum* L.). Sugar cane, as a raw material for the granulated sugar industry, must meet specified quality standards. It must meet the daily capacity of the sugar factory to achieve processing efficiency. The specified quality standards must meet the SCF criteria (sweet, clean, fresh). Sweet means that the sugar cane to be milled must have a high sucrose content; clean means free from dirt in the form of leaves, roots, soil, shoots, and young sugarcane; and fresh means the cut sugar cane must be milled immediately. Sugarcane entering the sugar factory must meet the factory's daily capacity. The daily capacity of the sugar factory must be met because if less sugarcane comes in it can cause the milling to stop or what is called stop hour A, whereas if there is too much sugarcane coming in it can cause a delay in milling so that the fresh criteria are not met. Shortages or excesses of daily sugar cane raw materials are something that sugar factories avoid.

A shortage of sugar cane raw material supply to the factory at a certain time will result in inefficient conditions because the factory cannot operate optimally (the factory can only operate optimally if the mill's milling capacity is met). On the other hand, an excess supply of sugarcane raw materials at a certain time will also result in the sugarcane raw materials experiencing "delayed milling", reducing the quality of the raw materials (Mahbubi, 2018; Pongoh, 2016). Therefore, supply chain management is very necessary to improve and maintain industrial stability regarding production, productivity, quality, protecting against uncertainty and improving supply chain performance (Maria Lokollo, 2012).

Many sugar factories in Java are currently experiencing problems with raw material availability. Several sugar factories were forced to close due to insufficient sugarcane raw materials. Madukismo Sugar Factory is currently also experiencing a shortage of raw materials. Over the past few years, Madukismo Sugar Factory has experienced a shortage of raw materials for sugar cane. Data on the realization of milled sugarcane compared to the company budget (CB) from 2018 – 2022 can be seen in Figure 1.

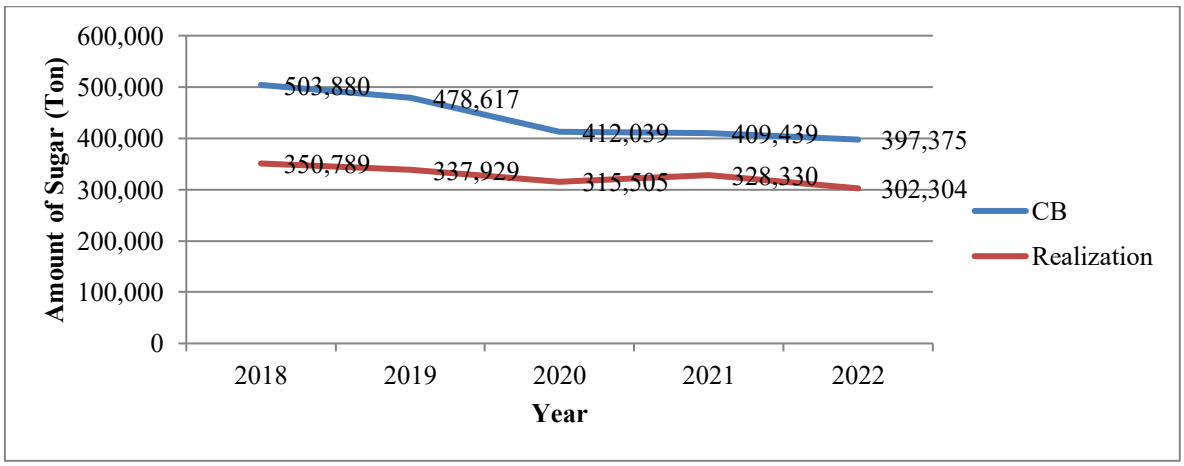

Figure 1. Comparison of Company Budget (CB) and Realization of Milled Sugarcane at the Madukismo Sugar Factory for 2018-2022
Source: Madukismo Sugar Factory (2022)

The currently installed capacity in Madukismo Sugar Factory is 3,500 TCD (a ton of cane per day), meaning that in one day (24 hours), the factory must mill 3,500 tons of sugar cane. If the daily

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amount of sugar cane available is below this figure, the sugar factory cannot operate optimally and sometimes has to stop milling. This condition is called stop clock A, namely stopping milling due to a lack of daily sugar cane supply. Risk management of raw material procurement is a crucial aspect for sugar mills to ensure the safety and quality of their products. It is important to recognize the potential hazards associated with raw materials, including biological, chemical, and physical pollution and allergens. These hazards can be brought into the manufacturing process through raw materials purchased from the front lines of the supply chain (Xiong et al., 2020).

Procurement of raw materials and sugar cane processing into sugar cannot be separated from one another. Suppose a sugar factory wants to get a high yield in processing sugar cane. In that case, sugar cane raw materials must be clean, fresh, and sweet and meet the daily milling capacity. Still, on the other hand, if the qualifications for clean, fresh, and sweet raw materials are met, but the processing process is not good, it will cause raw material suppliers, namely farmers, to become less enthusiastic about cultivating sugar cane. It can divert their sugar cane to other sugar factories so that the daily milling capacity of the sugar factory is not met. Procurement of raw materials and sugar cane processing is also an important part of the sugar cane supply chain.

An effective supply chain is one perspective used to increase competitive advantage to maintain the sustainability of a business (Pujawan & Mahendrawathi, 2017). An enterprise has been considered capable of addressing any interruption in the supply chain that hurts the profitability and effectiveness of the enterprise (Hendricks & Singhal, 2003). Efforts must be made to gradually and continually enhance supply chain performance by preventing and overcoming various risks that have the potential to emerge to decrease and overcome the numerous hazards that arise in the sugar cane supply chain.

The concept of supply chain risk management, which emphasizes preventative measures to lower the possibility of a risk agent happening, is the foundation of the House of Risk (HOR) model. In most cases, preventing the occurrence of risk agents also prevents the danger from occurring. A risk agent typically contributes to many risks. Risk management in HOR begins with identifying the risks to be handled. In this stage, a risk list will be produced based on the identification of risk sources. These risks have an impact on achieving company goals and objectives (Santillán-Saldivar et al., 2021; Tampubolon et al., 2014)

Applying the HOR method consists of two stages, namely HOR phase 1 and HOR phase 2. The steps in HOR phase 1 are risk identification and risk assessment, which includes assessing the level of impact (severity), assessing the level of occurrence, assessing correlation, and calculating the Aggregate Risk Potential (ARP) value so that risk agents can be identified who will be given preventive action by sorting the ARP values. HOR phase 2 begins with designing a handling strategy, looking for the magnitude of the relationship between the handling strategy and existing risk agents, calculating the Total Effectiveness (TEk) and Degree of Difficulty (Dk) values, and finally calculating the Effectiveness to Difficulty (ETDk) ratio, to find out the ranking priorities of existing strategies (Firmansyah et al., 2022; Kusnindah et al., 2015).

The HOR method for managing raw material procurement. This method focuses on finding solutions to raw material shortages.. The condition is highly critical, since the failure to meet the raw material requirements will result in the grinding machine's capacity not matching the installed capacity, leading to significant losses for the company. House of Risk (HOR) is a method used in risk management research in the procurement of raw materials and processing of sugarcane at Madukismo

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Sugar Factory, to prioritize which risk sources should be addressed first in order to take the most effective actions to reduce the potential occurrence of risks from these sources.

The essence of risk management is identifying risks and the main causes of risk. There are three important elements in managing risk using risk management, including (i) identifying risks, (ii) risk analysis, and (iii) designing risk responses (Sandhyavitri & Saputra, 2019). All hazards need to be recognized in order to properly apply risk management. Unknown hazards can potentially divert attention from the intended course of risk management (such as creating plans for risk reduction), leading to the adoption of unsuitable or ineffective risk-controlling tactics. (Ulfah et al., 2016).

Madukismo Sugar Factory must carry out comprehensive and structured risk identification, analysis, and mitigation in raw material procurement. It is necessary for Pabrik Gula Madukismo to identify, analyze, and mitigate risks in a comprehensive and structured manner when purchasing raw materials because, for at least five years after the company's founding, the quantity of raw materials has never exceeded. This has the potential to worsen the situation for the company. The objectives that need to be met are the number of unfulfilled positions in the workforce, the productivity of unfilled positions, and the number of unfilled positions in the target region (TLD). Therefore, to minimize risks and increase efficiency in procuring raw materials, appropriate risk management is required so that losses incurred can be prevented or reduced.

The novelty of this research lies in the fact that no such study has been conducted at PG Madukismo. The aim of this research is to find solutions to the current issues at PG Madukismo. A study is being conducted to identify the structured solution that should be prioritized for addressing the raw material issues at PG. Madukismo. The objectives of this research are: (1) identifying risk events and risk agents in the procurement of raw materials in Madukismo Sugar Factory, (2) analyzing risk agents that need to be prioritized for preventive action in procuring raw materials in Madukismo Sugar Factory and (3) determine risk mitigation priorities that need to be implemented in the procurement of sugar raw materials in Madukismo Sugar Factory.

RESEARCH METHODS

Research in Madukismo Sugar Factory is located in Tirtonirmolo Village, Kasihan Subdistrict, Bantul Regency, Yogyakarta Special Region using a case study method where Madukismo Sugar Factory is the only sugar factory in Yogyakarta Special Region. The Madukismo Sugar Factory was chosen as the research location because it is the only remaining sugar factory in the Yogyakarta Special Region (DIY). During the Dutch colonial era, there were 17 sugar factories in DIY. DIY is also a densely populated province and serves as a destination for education and tourism, resulting in a high demand for granulated sugar in this area. The sampling method uses nonprobability sampling with a purposive sampling technique. The sample selection criteria required and permitted to fill out the questionnaire in this study are as follows:

1. Respondents are active actors in the procurement of sugarcane raw materials (SRM) in Madukismo Sugar Factory, which is the Plant Section.
2. Respondents who understand the activities and risks in procuring raw materials at Madukismo Sugar Factory.
3. Respondents are experts in their fields, including the Plants Section and all sections in the Plants Section.

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Based on these criteria, respondents referred to 10 people from the Plant Section of the Madukismo Sugar Factory consisting of: 1 Head of Plant Section, 1 Deputy Head of Plant Section, 5 Heads of Rayon, 1 Head of Farming Facilities Development, 1 Head of Felling and 1 sugar cane outside the region Coordinator. The first research objective is to identify risk events and risk agents in raw material procurement by conducting direct field observations and carrying out Focus Group Discussions (FGD) with all respondents. Data analysis in this research uses the House of Risk (HOR) method, which includes two phases, namely HOR phase 1 and HOR phase 2. HOR phase 1 is used to answer the second research objective, namely analyzing risk sources (risk agents) that need to be prioritized for action prevention in the procurement of raw materials in Madukismo Sugar Factory. HOR phase 2 is used to answer the third research objective, namely determining risk mitigation priorities that need to be implemented in procuring raw materials in Madukismo Sugar Factory.

House of Risk (HOR) Phase 1

The HOR 1 methodology was employed to identify risks and their underlying causes. By utilizing HOR 1, generating the causes of prioritized risks and taking appropriate safeguards based on ARP values is possible. This model establishes a connection between a set of requirements (what) and a response (how) that demonstrates one or more needs. Specifically, the degree of correlation level was categorized as follows: zero, low (1), medium (3), and high (0), indicating absolutely no association (9). Every demand has a gap that has to be filled, and each answer will cost money and require specific resources. Following the aforesaid process, the following steps were taken to build HOR phase 1.

1. Determine the potential risk events for each business process. The supply chain (plan, source, make, deliver, and return) may be mapped out to do this, and the inadequacies or shortcomings in each phase can then be determined. The risk events are displayed as Ei in the left column.
2. Calculate the effects of many risk occurrences (if they occur). A scale of 1 to 10 is utilized in this instance, with 10 denoting tremendous effect. The risk event's severity, represented by the symbol Si, is listed in the table's right column.
3. Determine the sources of risk and evaluate the chance that each may materialize. A scale of 1 to 10 is used in this instance, where 1 denotes practically seldom happening and 10 denotes extremely often happening. The top row of the table contains the risk source (risk agent), which is related to the events in the bottom row by the notation Oj.
4. Create relationships in a matrix. Each risk source and each risk event have a connection known as Rij (0,1,3,9), where 0 denotes no correlation and 1,3,9, low, medium, and high correlation, respectively, are shown.
5. Compute a set of possible hazards (Aggregate Risk Potential of Agent j = ARPj), which is derived from the likelihood of an occurrence from risk agent j and the set of causal effects of every risk event brought on by the risk source, as expressed in the equation below:

$$ARP_j = O_j \sum S_i R_j$$

Information:

O_j : The probability of the risk source event j

S_i : The severity if risk event i occurs

R_j : The correlation between risk agent j and risk event i
(which shows how likely it is that risk source j is included in risk event i)

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6. Ranking risk agents based on a collection of potential risks in descending order (from large to small) (Ulfah et al., 2016).

Table 1. House of Risk Model Phase 1

Business Processes	Risk Event (E_i)	Risk Agents (A_j)							Severity of Risk Event i (S_i)
		A1	A2	A3	A4	A5	A6	A7	
Plan	E1								S1
	E2								S2
Source	E3								S3
	E4								S4
Make	E5								S5
	E6								S6
Deliver	E7								S7
	E8								S8
Return	E9								S9
Occurance of Agent j		O1	O2	O3	O4	O5	O6	O7	
Aggregate Risk Potential j		ARP1	ARP2	ARP3	ARP4	ARP5	ARP6	ARP7	
Priority rank of agent j		1	2	3	4	5	6	7	

House of Risk (HOR) Phase 2

HOR 2 is used to determine the first action/activity to be carried out, effectively considering differences such as resource involvement and level of difficulty in implementation. Companies need to ideally choose an action that is not difficult to implement but can effectively reduce the possibility of a source of risk occurring. The steps are as follows:

1. Select a number of risk sources with a high priority ranking that are possible using Pareto analysis from ARP_j, then stated in the second HOR. The selection results will be placed in (what) to the left of HOR 2 as depicted in table 2.
2. Identify relevant actions to mitigate risk sources. One risk source can be addressed with more than one action and one action can simultaneously reduce the likelihood of more than one risk source occurring. This action is placed on the top row as "How" in HOR 2.
3. Determine the relationship between each mitigation action and each risk agent, E_{jk}. The values (0,1,3,9) indicate respectively no correlation, low, medium and high correlation between action k and agent j. This relationship (E_{jk}) can be considered as the level of effectiveness of action k in reducing the probability of the risk agent occurring.
4. Calculate the total effectiveness of each action as follows: $TE_k = \sum ARP_j E_{jk} \forall_k$
5. Estimate the degree of difficulty in carrying out each action, Dk and put the values in a row in the bottom row of the effective total. The level of difficulty is indicated by a scale (such as a Likert scale) or other scale, and reflects the funds and other resources required to carry out the action. Calculate the effective total at the difficulty ratio $ETD_k = TE_k/D_k$.
6. Ranking the priority of each action (Rk) where ranking 1 means the action with the highest ETD_k (Ulfah et al., 2016).

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Table 2. House of Risk Model Phase 2

To be Treated Risk Agents (A_j)	Risk Mitigates (M_k)					Aggregate Risk Potentials
	M_1	**M_2**	**M_3**	**M_4**	**M_5**	**(ARP_j)**
A_1	E_{11}					ARP_1
A_2						ARP_2
A_3						ARP_3
A_4						ARP_4
Total effectiveness of action k	TE1	TE2	TE3	TE4	TE5	
Degree of difficulty performing action k	D1	D2				
Effectiveness to difficulty ratio	ETD_1	ETD_2	ETD_3	ETD_4	ETD_5	
Rank of Priority	R_1	R_2	R_3	R_4	R_5	

RESULT AND DISCUSSION

The Madukismo sugar factory has experienced several ups and downs since its establishment in 1956 until now. The main problem currently is the availability of raw materials. The demand is increasing while the supply is decreasing due to the diminishing agricultural or plantation land in DIY caused by the growing population needing housing facilities, schools, offices, etc.

Identification of Risk Events and Risk Agents in Procurement of Raw Materials

Based on direct observations in the field and the results of an FGD (Focus Group Discussion) with respondents procuring sugar cane raw materials at the Madukismo Sugar Factory, using supply chain operations reference (SCOR) mapping, 15 risk events were identified which were coded E_i as presented in Table 3.

Table 3. Risk Events in Raw Material Procurement

Process	Code	Risk Event
Plan	E1	Changes to the sugarcane import plan
Source	E2	Target for sugar cane area not achieved targeted 4.791,67 HA and real 4.487,61 ha (average 2018-2023)
	E3	Sugarcane productivity target not achieved (low yield) targeted 54,33 Ton/HA and real 42,95 ton/ha (average 2018-2023)
	E4	The target for the number of sugarcane outside the region (SOR) was not achieved targeted 186.166,67 ton and real 131.068,42 ton (average 2018-2023)
	E5	The total target for sugarcane raw materials (SRM) milled during one milling season was not achieved
	E6	Sugarcane raw materials (SRM) do not meet the sweetness criteria (S) targeted 17% and real 18% (average 2018-2023)
	E7	Sugarcane raw materials (SRM) do not meet the clean criteria (C) targeted 7% and real 6% (average 2018-2023)
	E8	Sugarcane raw materials (SRM) do not meet the fresh criteria (F) targeted 36 hours and real 31 hours (average 2018-2023)
	E9	The sugarcane plantation caught fire
Make	E10	Cost of production (COP) for sugarcane is high
	E11	Work accident

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	E12	Excess daily supply of sugarcane raw materials (SRM)
	E13	Shortage of daily supply of sugarcane raw materials (SRM)
Deliver	E14	Logging activities and equipment (grab loaders, trucks, cutting roads) are experiencing problems
	E15	Sugarcane receiving equipment (scales, lifting cranes, locomotives, lorries, rails) is experiencing problems
Return		

Source: Primary Data (2023)

Risk events are caused by one or several risk agents. Identified risk agent in raw material procurement at SF. There were 38 risk agents identified in the procurement of raw materials at the Madukismo Sugar Factory which were given the code A_j as presented in Table 4.

Table 4. Risk Agents in Procurement of Raw Material

Code	Risk Agents
A1	Abnormal climate
A2	Damage to sugar factory machinery
A3	Competition with non-cane commodities in obtaining land
A4	Transfer of agricultural land to non-agricultural use
A5	Farmers' interest in planting sugarcane has fallen
A6	Lack of regeneration of sugarcane farmers
A7	Limited funds (cash flow is not smooth)
A8	The quality of the sugarcane seeds is not good (old, the variety is not uniform)
A9	Non-compliance with SOP for sugarcane cultivation
A10	Repeated ratoon (more than 3 times)
A11	Plant density is less than standard
A12	Sugarcane plantation drainage is not smooth
A13	Delay in cultivation
A14	Rat pest attack
A15	Urethral pest attack
A16	Shoot or stem borer pest attacks
A17	White feather lice pest attack
A18	Disease attacks (smut, leaf rust, RSD etc.)
A19	Weeds are poorly controlled
A20	Human resources are not competent enough
A21	The price of sugarcane outside the region (SOR) is high
A22	Competition between Sugar Factory in obtaining sugarcane raw materials (SRM)
A23	Lack of accuracy in carrying out the assessment
A24	Land rental prices are high
A25	Prices of agricultural production inputs (inorganic fertilizers, herbicides, pesticides) are high
A26	Land conditions are not suitable for sugarcane cultivation (rocky, steep, thin solum, no cutting roads, etc.)
A27	Human error
A28	Excess felling labors
A29	Shortage of felling labors
A30	Logging activities are predominantly manual
A31	Maintenance of felling equipment is less than optimal
A32	Maintenance of sugar cane receiving equipment is less than optimal
A33	Incompatibility of varieties with Sugar Factory milling patterns

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A34	Non-uniformity of varieties within one garden
A35	Non-compliance with felling and transport SOPs
A36	Morning residue (cane that was not milled the previous day) is high
A37	Deliberately burning sugarcane plantations
A38	Accidentally setting fire to a sugarcane plantation

Source: Primary Data (2023)

Priority Risk Agents in Raw Material Procurement

Risk events and risk agents for procurement of raw materials are analyzed using HOR phase 1 to determine which risk sources/risk agents will be prioritized for preventive action. The results of the analysis using HOR phase 1 are presented in Table 5.

Table 5. Aggregate Risk Potential (ARP) of Risk Agents in Raw Material Procurement

Code	Risk Source	Average of ARP	Priority Rank of Agent	% ARP	Cumulative %ARP
A7	Limited funds (cash flow is not smooth)	2.783	1	6	6
A9	Non-compliance with SOP for sugarcane cultivation	2.176	2	5	10
A13	Delay in cultivation	1.927	3	4	14
A1	Abnormal climate	1.851	4	4	18
A19	Uncontrolled weeds	1.707	5	4	22
A5	Farmers' interest in planting sugarcane fell	1.687	6	4	26
A10	Repeated ratoon	1.657	7	3	29
A3	Competition with non-cane commodities in obtaining land	1.638	8	3	32
A35	Non-compliance with SOP for cutting and loading	1.543	9	3	36
A6	Lack of regeneration of sugar cane farmers	1.436	10	3	39
A29	Shortage of felling labors	1.432	11	3	42
A22	Competition between Sugar Factory in obtaining sugarcane raw materials (SRM)	1.431	12	3	45
A12	Sugarcane plantation drainage is not smooth	1.428	13	3	48
A20	Human resources are not competent enough	1.417	14	3	51
A11	Plant density is less than standard	1.410	15	3	54
A4	Transfer of agricultural land to non-agricultural use	1.324	16	3	57
A8	The quality of the sugarcane seeds is not good	1.261	17	3	59
A21	The price of sugarcane outside the region (SOR) is high	1.259	18	3	62
A15	Urethral pest attack	1.223	19	3	64
A34	Non-uniformity of varieties within one garden	1.191	20	3	67
A27	Human error	1.180	21	2	69
A33	Incompatibility of varieties with Sugar Factory milling patterns	1.173	22	2	72
A2	Damage to sugar factory machinery	1.119	23	2	74
A26	Land conditions are not suitable for sugarcane cultivation	1.104	24	2	77

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A25	Prices of agricultural production inputs are high	1.081	25	2	79
A14	Rat pest attack	1.078	26	2	81
A24	Land rental prices are high	1.026	27	2	83
A38	Accidentally setting fire to a sugarcane plantation	904	28	2	85
A30	Logging activities are predominantly manual	883	29	2	87
A31	Maintenance of felling equipment is less than optimal	875	30	2	89
A16	Shoot or stem borer pest attacks	828	31	2	91
A23	Lack of accuracy in carrying out the assessment	821	32	2	92
A37	Deliberately burning sugarcane plantations	806	33	2	94
A18	Disease attacks	694	34	1	95
A36	Morning residue (sugarcane that was not milled the previous day) is high	606	35	1	97
A17	White feather lice pest attack	586	36	1	98
A32	Maintenance of sugarcane receiving equipment is less than optimal	530	37	1	99
A28	Excess felling labor	418	38	1	100
	Total	**47.489**		**100**	

Source: Primary Data (2023)

Aggregate risk potential (ARP) data on raw material procurement risk agents (Table 5) is made into a Pareto diagram as follows:

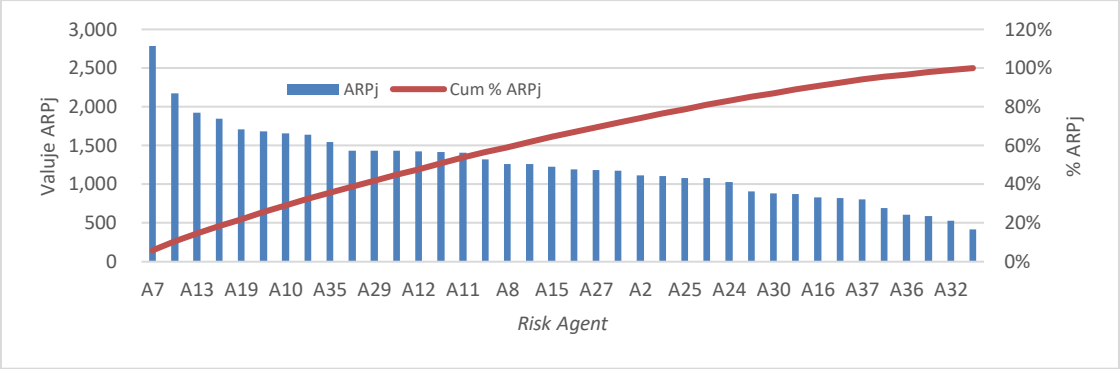

Figure 2. Pareto Aggregate Risk Potential (ARP) Diagram

Based on Table 5 or Figure 2, there are 14 priority risk agents (having the largest ARP and a cumulative ARP percentage of up to 51%) in the procurement of raw materials in Madukismo Sugar Factory is:

1. Limited funds (cash flow is not smooth)
2. Non-compliance with the SOP for sugarcane cultivation
3. Delay in sugarcane cultivation
4. Abnormal climate
5. Weeds are less controlled
6. Farmers' interest in planting sugarcane has fallen
7. Repeated ratoon (more than 3 times)
8. Competition with non-cane commodities in obtaining land
9. Non-compliance with the SOP for cutting and loading

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10. Lack of regeneration of sugarcane farmers
11. Shortage of felling labors
12. Competition between sugar factories in obtaining sugarcane raw materials (SRM)
13. Sugarcane plantation drainage is not smooth
14. Human resources are incompetent

Priority risk agents including abnormal climate/weather, pests, diseases and weeds were also found in the seaweed business carried out by Puspitasari & Hasan (2021). Meanwhile, farmers' human resources are less interested in cultivating sugar cane, which is in line with the research results of Puspitasari & Hasan (2021) and (Octaviani et al., 2020).

Risk Mitigation in Raw Material Procurement

The results of direct observations in the field and FGD (Focus Group Discussion) with respondents obtained mitigations for each priority risk agent. Mitigation of each risk agent is arranged or sequenced. The same or similar mitigations are combined into one. There are 22 risk mitigations coded as M_k to handle the 14 priority risk agents. The risk mitigation was analyzed using HOR phase 2, obtaining the following priority order (rank of priority) for raw material procurement risk mitigation:

1. Reformulate the SOP for cultivating seed sugarcane and milled sugarcane specifically for the Madukismo Sugar Factory
2. Carry out HR training with or without involving third parties
3. Provision of funds and production facilities on time
4. Discipline in implementing the SOP for seed sugarcane and milled sugarcane through reward and punishment
5. Increased supervision by each Plant Department personnel
6. Benchmarking (comparative study) to other Sugar Factory
7. Change the status of the partnership sugarcane to independent people's sugarcane
8. Improve services to sugarcane farmers and landowners
9. Increase research and development activities and functions in the Plants Department
10. Cost-effectiveness and efficiency
11. Provide an example of good sugarcane cultivation to farmers
12. Reformulate the Madukismo Sugar Factory-specific felling and transport SOP.
13. Use of cut and load mechanization technology and optimization of grab loaders
14. Be more selective in employee recruitment, especially in the Plant Department
15. Provide special facilities to new sugarcane farmers and millennial sugarcane farmers
16. Conduct a forward sale of sugar (selling sugar before it is milled)
17. Anticipating climate change and monitoring with the Meteorology, Climatology and Geophysics Agency (BMKG)
18. Discipline in implementing the SOP for cutting and loading and transporting through reward and punishment
19. Carry out business collaboration with other parties
20. Looking for new sources of logging labors and educating new logging labors
21. Looking for investors/lenders
22. Sell some company assets.

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The order of 1 to 5 mitigation from priority risk agents in raw material procurement can be described as follows:

Reformulate the SOP for Cultivating Seed Sugarcane and Milled Sugarcane Specifically for the Madukismo Sugar Factory

Specific sugarcane cultivation refers to the cultivation of sugarcane that is suitable to be carried out at Madukismo Sugar Factory, considering the specific conditions of the soil, location, social community, and the current agricultural machinery available. This aims to ensure that raw materials' desired quantity and quality can be achieved while maintaining controlled costs. Although general techniques for cultivating sugarcane are already available and can be found in many literature sources, specific or unique sugarcane cultivation methods used in the Madukismo PG working area need to be redefined. Currently, PG. Madukismo possesses self-made agricultural machinery such as sugarcane planting machines, fertilizer applicators, plows, harrows, and fillers, among others, which are created by PG. Madukismo personnel themselves rather than being factory-made agricultural machinery. In procuring sugarcane raw materials in Madukismo Sugar Factory, the responsibility of the Plants Department is to reformulate the SOP for sugarcane cultivation specifically for Madukismo Sugar Factory. There are many guides on cultivating sugarcane well, but they are still general in nature. With the existence of a specific sugar cane cultivation, SOP can be a guide for foremen, cinders, and farmers, and it is easier to evaluate if deviations occur, whether because the SOP is not appropriate or because the perpetrators lack discipline in implementing the SOP. Actually on Madukismo Sugar Factory once had a specific sugarcane cultivation SOP. However, Madukismo's SOP is no longer up to date and has not been properly socialized for a long time.

A Soemohadiwidjojo (2014) stated that Standard Operating Procedure (SOP) is a guide used to ensure that the operational activities of an organization or company run smoothly. The use of SOPs in organizations aims to ensure that the organization operates consistently, effectively, efficiently, systematically, and well-managed to produce products that have consistent quality in accordance with established standards. Broadly, SOP can be defined as a document that describes an organization's operational activities. However, in a narrow sense, SOP (or "procedure") is a type of document in a work procedure system that is used to regulate operational activities between sections/functions in an organization so that these activities can be carried out systematically. It is important for companies to apply Standard Operating Procedures to every activity in the company in order to achieve effective and efficient work productivity (Nabilla & Hasin, 2022).

SOP for sugarcane cultivation in PG. Madukismo can generally follow the Minister of Agriculture's regulation no. 53 of 2015 concerning Guidelines for Good Agricultural Practices (GAP for Sugarcane) and a pocket book from PT. Rajawali Nusantara Indonesia is sugarcane cultivation in rice fields and moorlands, but it must be adapted to the specific conditions in the Madukismo Sugar Factory work area. Existing SOPs require revision to address contemporary issues and requirements. In the past, cultivation relied on a pure Reynoso system. However, due to a decrease in the number of workers and the narrowing of agricultural land plots, it is no longer feasible to continue using this system. As a result, the use of mechanized machines must be adjusted to the current conditions, ensuring that they can operate effectively within the limited space available. The current Standard Operating Procedure (SOP) for sugarcane farming in PG. Madukismo is fragmented and lacks comprehensiveness. It has not been systematically organized into a clear benchmark for evaluation. Therefore, it is necessary to assess if the existing SOP is worth retaining or if it requires revision.

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Carry Out HR Training with or Without Involving Third Parties

According to Rozalena and Dewi (2017), training is a series of structured activities to improve skills, experience, and expertise, increase knowledge, and change an individual's attitude. Activities or implementation of training in a company or organization should be designed based on existing needs. through a series of processes. The process in question is realizing and seeing the fact that there is a decline in employee performance, productivity, and competence in carrying out their duties or pursuing their targets (Nugroho, 2019). Human resources in the Plant Department, as the section responsible for fulfilling raw materials, need to undergo training to develop their mindset and skills. This training can be carried out independently by the Plant Department by transferring knowledge and skills from senior employees to new employees. Training can also involve relevant third parties or external parties. The current state of human resources and training at Madukismo Sugar Factory. Training is still infrequently conducted; for example, there may not be regular training for operational employees. The training is still being conducted piecemeal by each respective department, with little involvement from the HR department. Meanwhile, for executive employees, there are BMDP (Basic Management Development Program) and MMDP (Middle Management Development Program) in collaboration with educational institutions such as LPP (Lembaga Pendidikan Perkebunan) Yogyakarta, although these opportunities are still quite rare.

Provision of Funds and Production Facilities on Time

Funds or financing and production facilities (fertilizers, herbicides, pesticides, etc.) are like blood flow in the Plant Department. Without financing and production facilities available on time, land procurement activities for sugarcane plants and cultivation work will be hampered and raw material procurement targets cannot be met properly.

Discipline in Implementing the SOP for Seed Sugarcane and Madukismo SF. Milled Sugarcane Through Reward and Punishment

There are three important functions of punishment that play a major role in shaping expected behavior: (1) limiting behavior, (2) being educational, (3) strengthening motivation to avoid unwanted behavior (Kawulur et al., 2018). After there is an SOP for sugarcane cultivation, there needs to be reward and punishment so that the SOP is carried out properly and correctly. Without reward and punishment, perpetrators/officers will be less enthusiastic about implementing SOPs, and there will be many deviations. Punishment must be done wisely, whether deviations from SOPs occur because of their implementation or because of other factors, for example, cash flow irregularities or lack of timely production inputs.

Increased Supervision by Each Plant Department Personnel

Supervision is the process of determining performance measures and taking actions that can support the achievement of expected results in accordance with the performance that has been determined (Tisnawati Sule & Saeful, 2019). In every action carried out by the company, there needs to be supervision that directs employees so that they can carry out their work correctly and in accordance with what has been determined. The most appropriate person to carry out supervision over this discipline is, of course, the direct superior of the employees concerned (Kamal, 2015; Octaviani et al., 2020). In order to handle risks in raw material procurement, increasing supervision is very important. Every personnel in the Plants Department needs to increase supervision, especially

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in searching for areas, cultivation activities, cutting and transporting, and purchasing sugarcane outside the area so that the SOPs that have been made are implemented well and the results obtained are in accordance with what was planned. It is also necessary to create an integrated plantation monitoring system, including monitoring whether supervision has been carried out properly and correctly.

CONCLUSION AND SUGGESTION

Procurement of sugar raw materials at the Madukismo Sugar Factory identified 15 risk events with 38 risk agents. There are 14 agents of risk prioritized for taking preventive action in the procurement of raw materials, namely: (a) limited funds (cash flow is not smooth), (b) non-compliance with SOPs for sugarcane cultivation, (c) delays in cultivation, (d) abnormal climate, (e) weeds are less controlled, (f) farmers' interest in planting sugar cane has decreased, (g) shortages have increased more than 3 times, (h) competition with non-cane commodities in obtaining land, (i) non-compliance with SOPs for cutting and loading, (j) lack of regeneration of sugarcane farmers, (k) shortage of felling personnel, (l) competition between sugar factory in obtaining raw materials, (m) plantation drainage is not smooth and (n) inadequate human resources. There are 22 risk mitigation measures to address priority risk sources in the procurement of raw materials, ranked 1-5, namely: (a) reformulating the SOP for cultivating seed sugarcane and milled sugarcane specific Madukismo Sugar Factory, (b) carrying out HR training with or without involving third parties, (c) providing funds and production facilities on time, (d) disciplining the implementation of SOPs for seed cane and milled sugar cane through reward and punishment and (e) increasing supervision by each personnel Plant Parts.

The Plant Department of the Madukismo Sugar Factory, as the section responsible for procuring raw materials, needs to immediately reformulate the SOP for cultivating seed sugarcane and milled sugarcane specifically for the Madukismo Sugar Factory so that there are strict guidelines for cultivating sugarcane. Apart from that, it is necessary to carry out HR training to increase employee capacity, provide funds and production facilities on time, implement stricter rewards and punishments for discipline in implementing SOPs, and increase supervision by each Plant Department personnel.

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