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FRAMEWORK OF RISK MITIGATION OF MANAGEMENT OF REFINED SUGAR SUPPLY CHAIN WITH THE HOUSE OF RISK MODEL

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ABSTRACT

Nowadays refined sugar supply chain is often occured risk (disruption)that the complained by food industry, beverage and pharmaceutical industries as consumer of refined sugar. The purpose of this research is to design a risk management model of refined sugar supply chain and realized in the framework of risk mitigation actions.The method used in the identification and evaluation constitute development of method Failure Modes and Effect Analysis (FMEA) and Quality Function Deployment (QFD), while the determination of the criteria in the process business was using Supply Chain Operation Reference (SCOR) dimension. Of the research methods used will be developed a formulation the value potential risks for determining priority risks agent will be mitigated by the approach House of Risk (HOR).HOR1 is used to rank each risk agent based on their aggregate risk potentials. HOR2 is intended to prioritize the proactive actions that the company should pursue to maximize the cost-effectiveness of the effort in dealing with the selected risk agents in HOR1. The results of the HOR model was to handle 24 risk agent by implementing 22 risk mitigation actions.

Keywords: Risk, framework, mitigation actions, House of Risk

INTRODUCTION

Nowadays, there are many risks/disruptions occurred in the refined sugar supply chain that are complained by the food, beverages, and pharmaceutical industries as the consumers of refined sugar. The risks are such as loss contain (the reduced weight of the product), contamination on the package of the refined sugar product, the reduced production due to the disrupted supply of coal and electricity power, mechanical issues, natural disasters, and many other risks that disrupt

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the supply to the final consumers that disserves the consumers (food, beverages, and pharmaceutical industries). Many arising risks related to the supply chain cause dissatisfaction on the consumers. The dissatisfaction factors are related to the risks occured on the supply chain from the raw materials until to the consumers, therefore, the function of supply chain management is required to create competitiveness advantages of a company that are characterized by the fulfillment of consumers' satisfaction on quality, quantity, and time delivery (Vorst 2004).

In the supply chain process there are many risks found that may affect the flow of the supply chain to not run smoothly. Risk in the supply chain can be defined as the disruption on the flow of information and resources in the supply chain network for the termination and uncertain variation (Juttner et al. 2003). Risk can be defined as the measurement of chances and severity of undesirable impact (Haimes, 2009). Risk is a variation of results appeared for certain period as a result of certain situations (IOSH, 2002). Risk indicates variation of results, expressed as a measurement of the level of the opportunities and severity. Opportunities can be expressed as a probability (Lam 2003), frequency, probability of frequency (Haimes, 2009), occurence (Mc.Dermott et al. 2009).

In accordance with the risk in supply chain management, the role of risk management is essential to keep supply chain system undisrupted. The process of supply chain risk management consists of risk identification, risk analysis, risk assessment and risk mitigation. The identification of becomes a fundamental stage in the risk management process (Hallikas et al., 2004; Norman & Lindroth, 2004).

Based on these problems, it is necessary to reduce and overcome a variety of risks occur in the supply chain and prevent the occurrence of various risks. The measurement of supply performance would be beneficial if the results of these measurements become the basis for improvement. Therefore, the approach to the process of mapping the current processes and determining the processes that are ideal or desirable. One of the models of supply chain performance measurement system is based on the Supply Chain Operations Reference (SCOR), therefore it requires a framework of mitigation actions in the risk management of refined sugar. This can be done through the design of risk management model of refined sugar supply chain.

The purpose of this study is to design the risk management model of refined sugar supply chain which is realized within the framework of mitigation actions of refined sugar supply chain activities in the form of House of Risk model.

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RESEARCH METHOD

Framework

This research is based on designing a framework proactively to manage the Supply Chain Risk by designing a House of Risk framework completed with the top of HOR matrix components in the refined sugar mill. The model that is designed in a supply chain risk management includes the measurement of performance of refined sugar supply chain. In complete, the framework can be shown in Figure 1 below.

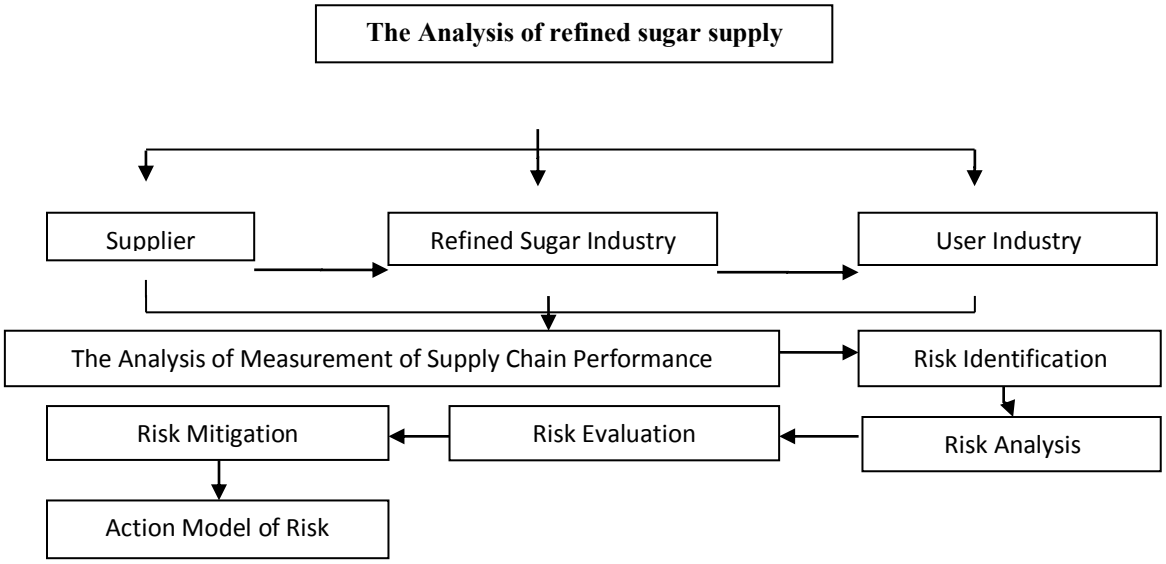

Figure 1: Research Framework

Research Methodology

The research methodology conducted referred to a framework developed by the researcher, consists of steps and basis in identifying, analyzing, risk evaluating and designing the mitigation strategy in company supply chain. The concept of risk used referred to the definition of risk according to Australian/New Zealand standard (Hart B, 2006) and BSI (UK). Meanwhile, the mitigation strategy used referred to the proactive strategy developed by Tang (2005).

There are 5 steps in this research, they are; (1) preparation, (2) performance measurement, (3) risk identification, (4) risk management, (5) mitigation actions design of supply chain risk. In complete, the research steps are shown in Figure 2 below

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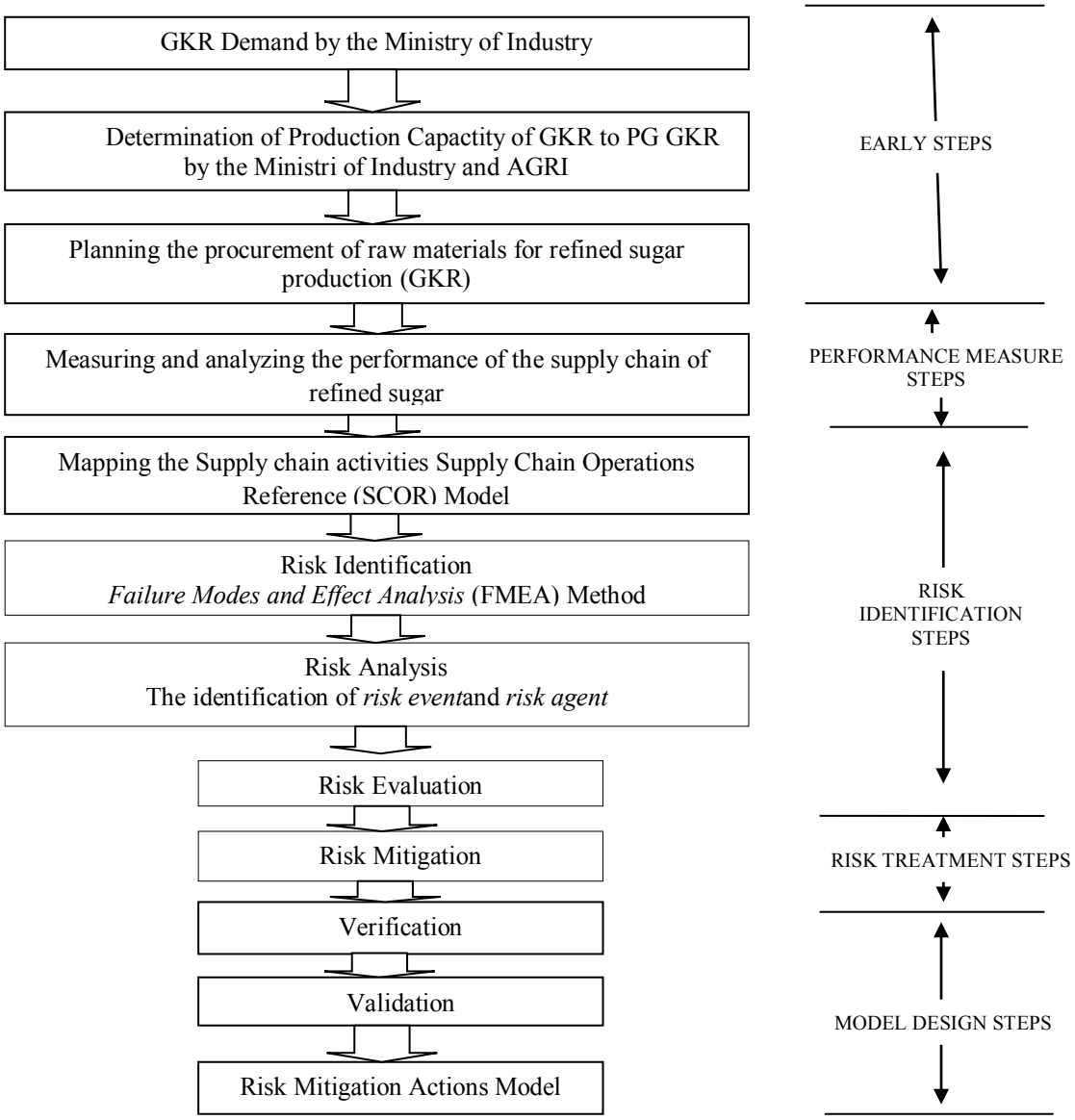

Figure 2

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RESULTS AND DISCUSSION

The Analysis of Kano Category Mapping

Based on the steps of Kano Method (Noriako Kano, 1984) that is attributes identification for function and dysfunction question, validity and reliability tests, attributes classification and Kano category map, by conducting the steps, it can obtain the map between the user industry (consumer) and manager (manager industry) respondents to see the suitability of the preferences. The questionnaires mapping is shown on Table 1 below.

Table 1 The comparison of mapping of manager and user industries in Kano Model Category

SCOR Dimension	Manager Industry	User Industry
Plan	*One Dimensional*	*Attractive*
Source	*One Dimensional*	*One Dimensional*
Make	*One Dimensional*	*One Dimensional*
Deliver	*One Dimensional*	*One Dimensional*
Return	*One Dimensional*	*Must Be*

The table shows that for the SCOR dimensions such as source, make and deliver have compatibility / suitability that is categorized as one dimensional. While the dimensions plan and return have different opinions or views. On the dimension of plan, the consumer chooses the attractive category while manager industry chooses one dimensional. In this case, the user industry is satisfied if the performance of the supply chain services are available but if the service performance of the supply chain services are not available the user industry will be disappointed. Meanwhile, the manager industry thinks otherwise that it will be very satisfied if the performance of the supply chain services are available, otherwise it will be dissatisfied if the performance of the supply chain services are not available.

For the dimension of return, the user industry chooses the must be category (basic category) while the manager industry chooses the one dimensional category. In this case, the user industry will be extremely dissatisfied feel if the performance of the supply chain services are not fulfilled, while if the services are fulfilled it will not increase the satisfaction of the user industry since the industry considers that this dimension is should be available / fulfilled. Meanwhile, the manager industry will be highly satisfied and vice versa if the performance of supply chain services are not fulfilled.

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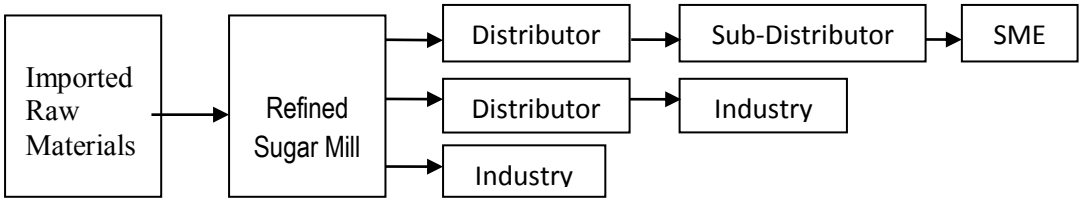
The Mapping of Supply Chain Activities

The mapping of the supply chain activities is determined by the SCOR dimensions consisting of plan, source, make, deliver and return and are the major processes of the business process of supply chain, in which the major processes consist of several sub-processes. Then, there are some risk events identified from the sub-processes. The plan major process includes the sub-processes of plan forecast, production planning, material inventory control, supply chain adjustment to financial planning, and capacity planning. The source major process includes the sub-processes of scheduling the delivery of raw materials from suppliers, receiving the delivery of raw materials, checking the delivery of raw materials, and authorizing the payment of raw materials sent by the suppliers, selecting suppliers, evaluating the suppliers' performance and procurement processes. Make major process includes execution and control of production, packaging process, production scheduling, production quality test, and production. Deliver major process includes the sub-processes of delivery selection, warehouse for finished products, and invoice sending to the user industries. Return major process includes the sub-processes of rejected products return, management of returns from industrial users, and management of rejected products returned by the user industries.

The steps of refined sugar supply chain activities are shown on Figure 3.



Source: PT.Jawamanis Rafinasi

Figure 3: Refined Sugar Supply Chain

The Analysis of Risk Mitigation

Overall, the steps in the framework of risk mitigation by using the HOR approach are divided into 2 phases; risk identification and risk treatment phases. The data input the the HOR 1 model (risk identification phase) and HOR 2 model (risk treatment phase) developed in this research can be shown in Figure 4 and 5.

***House of Risk*1 (Risk Identification)**

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The House of Risk 1 (HOR 1) model is used to determine which risk source that is prioritized to be prevented (Geraldin, L. Het al.2007). HOR 1 consists of the components shown in Figure 4 as follows:

1. *Where are the risk* is the major process of supply chain with SCOR dimension
   The identification of the business/activity processes of supply chain of the company is based on the SCOR model (plan, source, make, deliver dan return). The division of this process aims at determining which risk that can raise (*Where are risk*)

2. *Risk event* is the risks occured in the supply chain activities
   The identification of risk event for each business process that had been identified in the previous steps. This risk is all events that may raise and cause disruption.

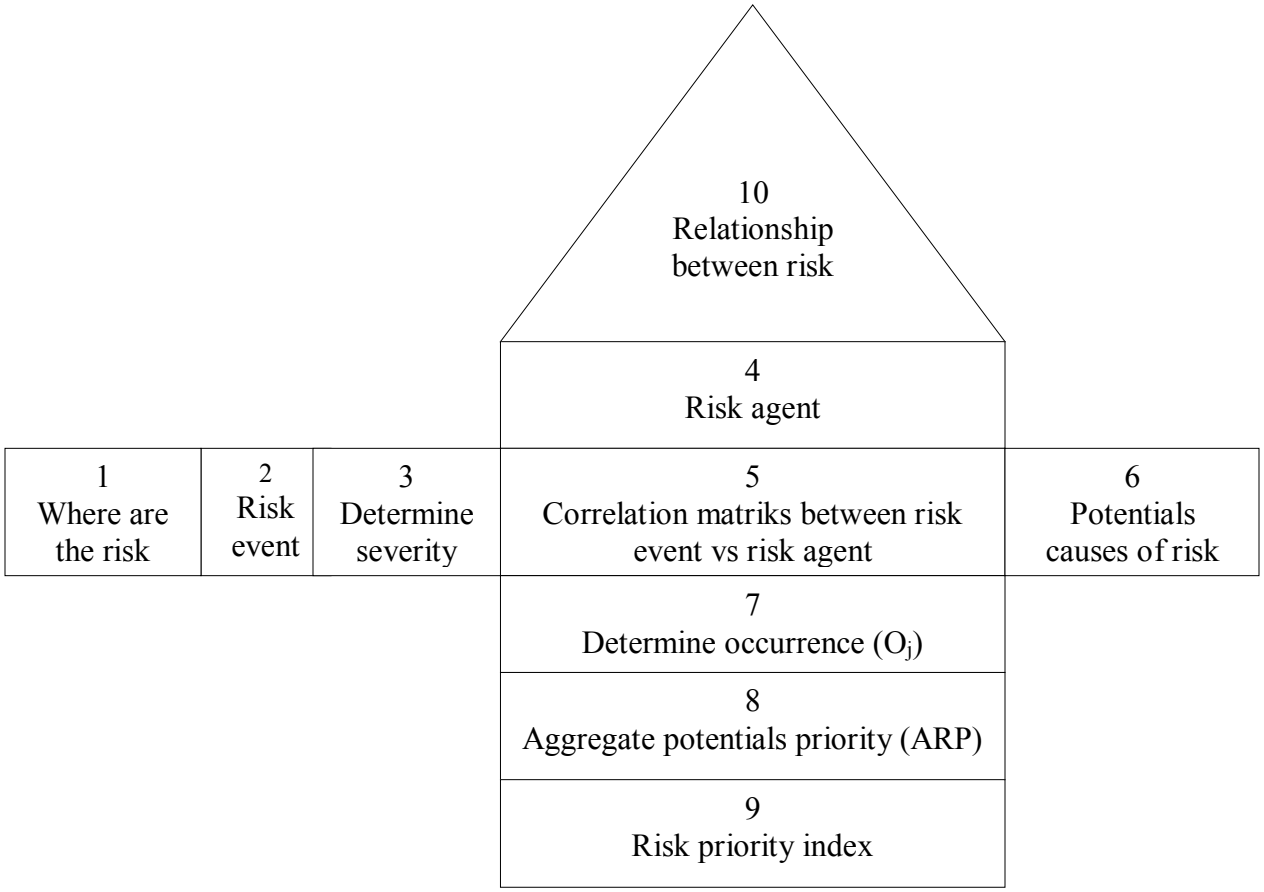

Figure 4: Risk identification

3. *Determine severity* illustrates the severity of a risk

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The identification of severity of a risk event towards the business process of the company. The severity value states how great the disruption resulted from a risk event towards the business process of the company. The scale used in determining the severity is the scale of 1 – 10.

4. *Risk agent* is the cause of the risk that is possible to result in a risk event.
   The identification of risk agent/cause is identifying the risk agent that can result in the identified risk event.
5. *Correlations matrix* explains the correlation between the risk event and risk agent. This correlation will show 0 for no correlation and 1, 3, 9 to show the low, medium, and high correlation, respectively.
6. *Potentials causes of risk (Potentials impact)* illustrates the impact that may be resulted from the available risk.
   The identification of *potentials causes of risk* towards the business process of the company. These *Potentials causes of risk* state the impact of disruption that may be resulted in a risk event.
7. *Determine occurence* illustrates the risk occurrence level.
   The identification of occurrence chance states the level of occurrence frequency of a risk agent so that results in one or more risk events that can result in disruption on the business process with certain impact. The scale used in determining the occurrence is the scale of 1 – 10.
8. *Aggregate Potentials Priority (ARP)* illustrates the aggregate risk potential
   The calculation of *Aggregate Risk Potential of agent j* =ARP_j). This ARP value will be used as a consideration to determine which Aggregate Potensials Priorirty that must be conducted in treating/managing risks.
9. *Risk priority index is the risk priority (rank of risk priority) Creating the risk priority index based on the aggregate risk potential in the order descendats (from the highest to the lowest value)*
10. *Relationship between risk agent illustrates the relationship between the risk agents Relationship matrix illustrates the relationship between a risk agent with another risk agent. The relationship/correlation between the risk agents with the notation of* Ra_{ij} *(0, θ, *, •) where 0 shows no correlation andθ, *, •each shows weak, medium, and strong correlation, respectively.*

House of Risk 2 **(Risk Treatment)**

The second phase of HOR is conducted for risk treatment of the risk agents that have been identified and are on the high level (Pujawan and Laudine H. Geraldin. 2009). The output of HOR phase 1 will be used as the input for phase 2. The phase 1 of HOR will obtain the risk priority value and risk level of each risk agent that has been identified. The risk agent that is in

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the high level on phase 1 will become the input on phase 2. The short brief of the steps of phase 2 of HOR is shown in Figure 5.

Step 1: Determining the risk agents that will be treated based on the risk level on HOR 1
Step 2: Designing the strategy of mitigation actions
Step 3: Mapping the risk events that may be resulted from the risk agents.
Step 4: The correlation between the mitigation actions and to be treated risk agent. This correlation will show 0 for no correlation, and 1, 3 ,9 for low, medium, and high correlation, respectively.
Step 5: *Total effectiveness of proactive*
Step 6: *Difficulty of performing action k*
Step 7: *Effectiveness to difficulty ratio of action k*
Step 8: *Rank of proactive action k (Rk)*
Step 9: *Relationship between mitigation action*

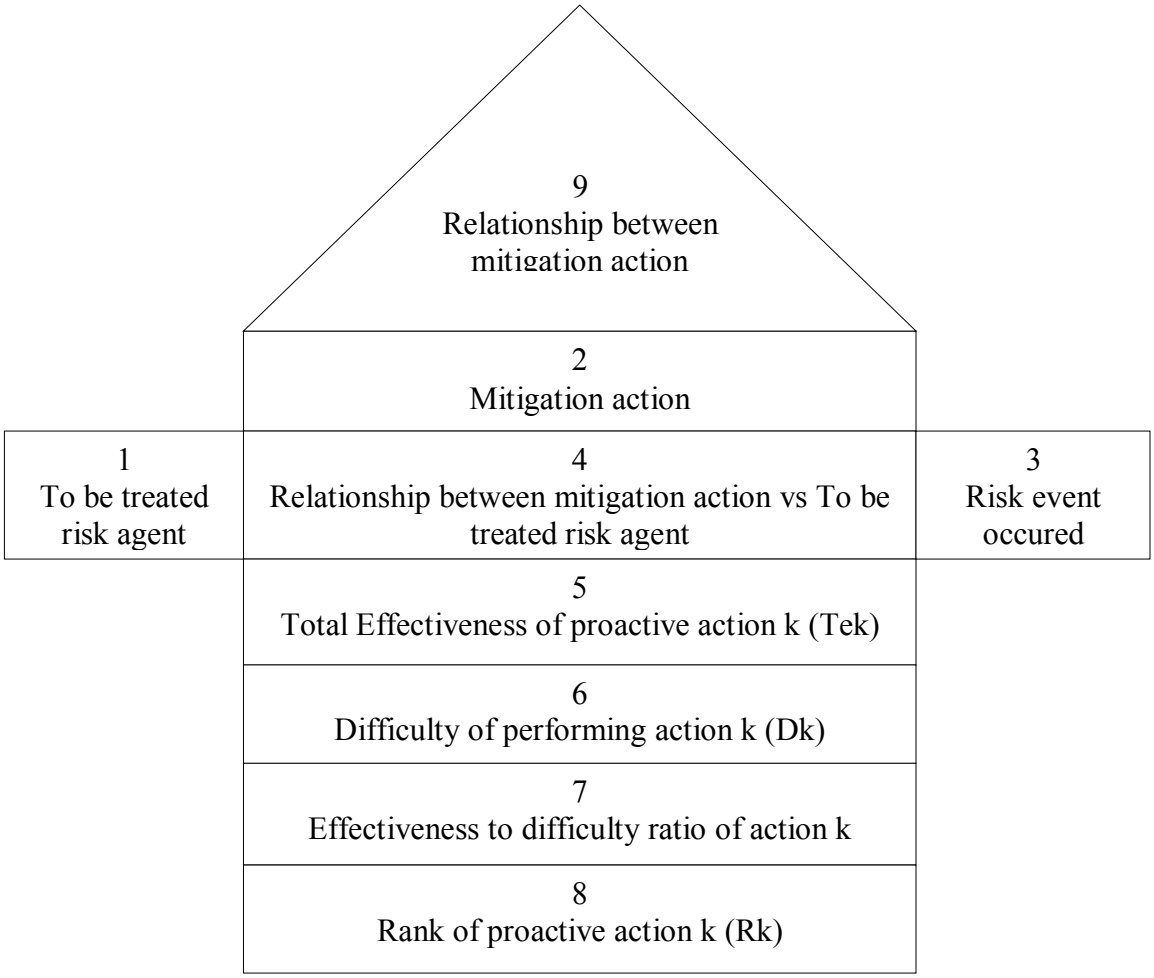

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Figure 5 Risk treatment

The Identification of Risk Event Possibility

The risk event is identified by detailing the disruption of each sub-process. In the business resources, the process follows in five criteria / sources of supply chain business process of Supply Chain Operations Reference (SCOR) method. Based on the identification, there are 47 risk events in detail consist of 6 possibilities of risk event from the plan business process, 12 from source, 15 from make, 11 from deliver, and 3 from return. Risk identification in the refined sugar supply chain is conducted by analyzing the source-based risks. The risk is the type of operational risk that is divided into 5 SCOR dimensions, namely the risks contained in plan, source (procurement), make (production), deliver and return. Risk identification consists of 5 business processes of SCOR-dimensions-based supply chain activities.

Risk Agent Identification

Managing the supply chain is easy and is a challenge for a company (Pujawan,2005) since actually, it involves several parties both inside and outside of the company. From the identification, there are 47 risk agents with different frequencies for each risk agent. The identified risk agents can result in more than 1 risk event. It can be shown in the correlation between the risk agent and risk event.

Aggregate Risk Potentials (ARP) Analysis

Aggregate Risk Potential (ARP) was calculated from each risk agent. The Pareto Diagram of ARP values for 47 risk events, shows the highest value of 3320, 12 risk agents with the ARP values between 1088 to 3320 and 14 risk agents with the ARP values between 504 to 927 and the rest have ARP values below 500. Furthermore, there are 10 of 47 risk agents contribute approximately 50% of the total ARP values, while there are about 24 risk agents contribute 80% of total ARP. The ARP ranks of the largest to the smallest from the risk agents the ARP Pareto Diagram are shown in Figure 6.

The classification of risk agents that is based on the Pareto diagram 80 : 20 is divided into three classifications, namely classification A (high risk agents), classification B (medium risk agents), and classification C (low risk agents). Based on the Pareto diagram above, there are 24 risk agents that cover 80% of 47 risk agents that is in the order of the highest priority from number 1 to 24. From the pareto diagram, 50% of the risks are potential to be generated by classification A risk agents, 30% of risks are potential to be generated by classification B risk agents, and 20% of

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the risks are potential to be generated by classification C risk agents. The value of 23.4% risk agents are at classification A which means that it has a high level of occurrence, 27.66% at classification B which means that it has a medium level of occurrence and 48.94% at classification C which means that it has a low level of occurrence.

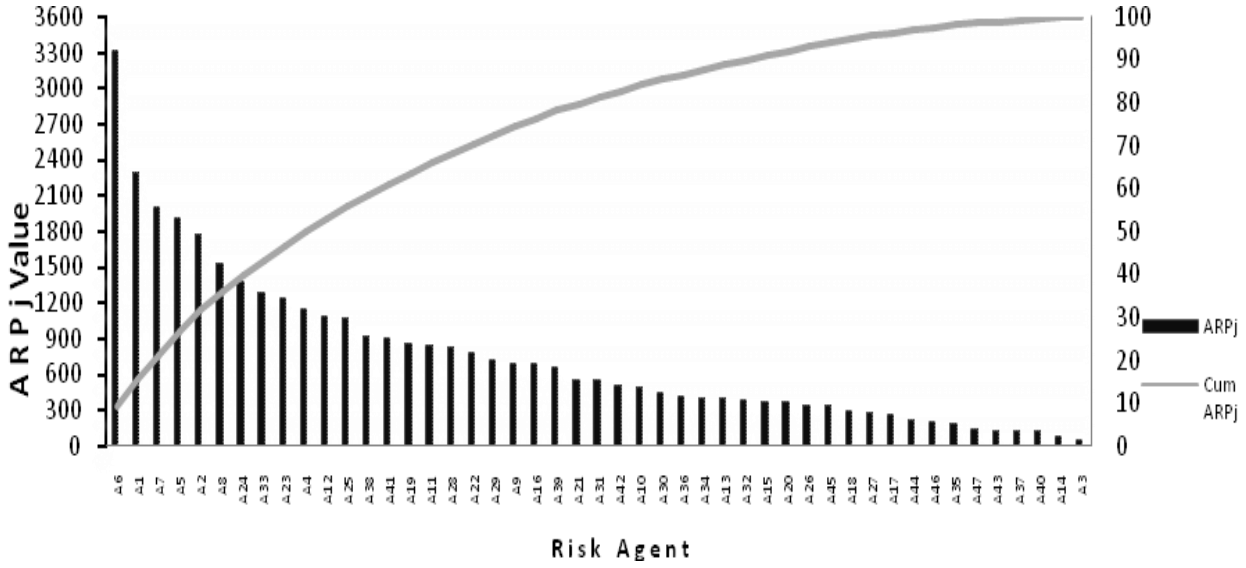

Figure 6 Pareto Diagram of ARP values

The Analysis of House of Risk 1 (HOR1)

Overall, House of Risk 1 generates the ARP values and priority that will be managed for mitigation based on the pareto diagram as shown in Figure 6. In principle, HOR 1 is used to determine which risk agents prioritized to be prevented, while HOR 2 is to make the action priority by considering the effective-cost resources. Based on the pareto diagram (Figure 6), there are 24 risk agents contribute to 80% of the total ARP and risk agents that will be mitigated.

The Analysis of House of Risk 2 (HOR2)

In the phase of House of Risk 2 (HOR 2) obtain the calculation of total effectiveness of each action with a formula of $TE_k = \sum_j ARP_j$. The Pareto Diagram from the value of *Effectiveness to Difficulty Ratio of Action k* (ETD_k) can be shown in Figure 7.

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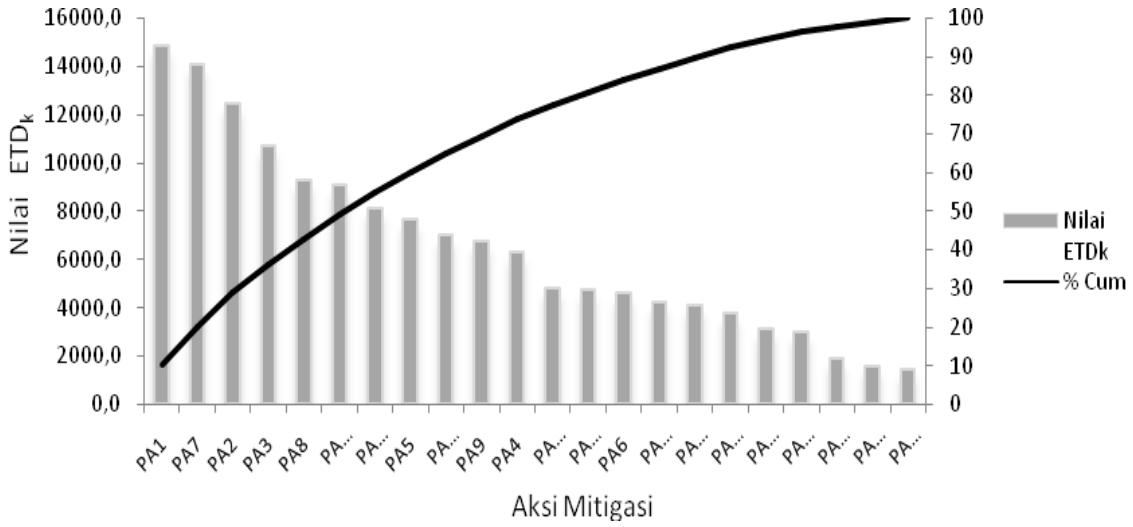

Figure 7 ETD Pareto Diagram

Risk Response

The correlation value between the risk agents with mitigation actions is 9 (strong correlation) which means that the mitigation actions are very effective in reducing the chance of risk agents' occurrences, 3 (medium correlation) which means that the mitigation actions are fairly-effective in reducing the chance of risk agents' appearaces, and 1 (weak correlation) which means that the mitigation actions are less-effective in reducing the chance of risk agents' occurrences. Meanwhile the difficulties scales will be used if the mitigation actions use the scale of 5 (very difficult), 4 (difficult), 3 (fair), 2 (easy), and 1 (very easy). The supporting factors that affect the difficulties are Human Resources, materials, time, etc. The correlation between ETD values and difficulty level can be shown in Figure 8.

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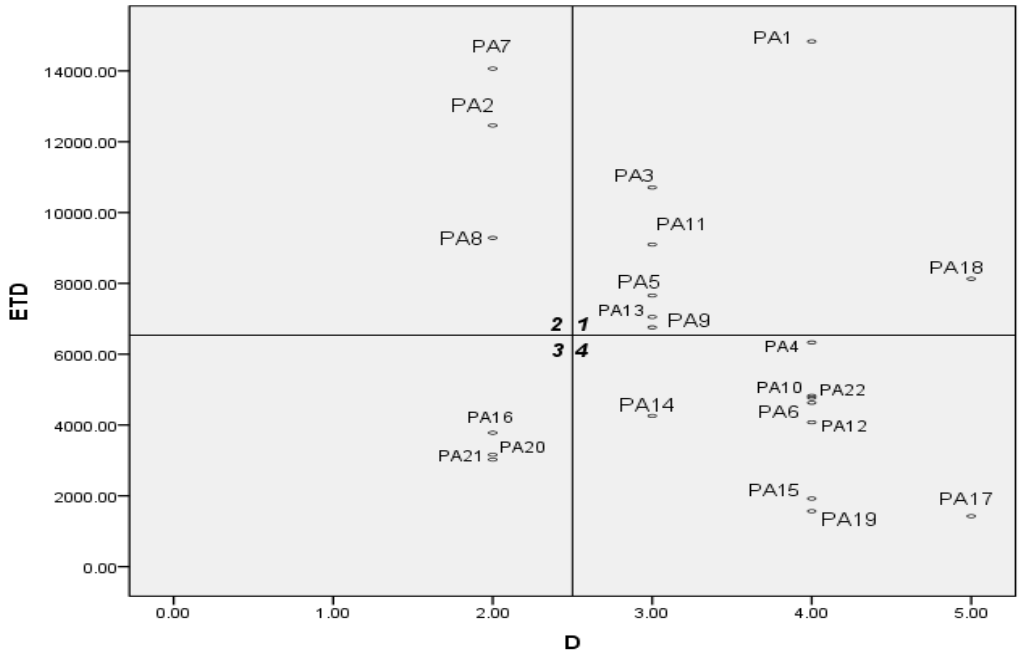

Figure 8 The Quadrant of Mitigation Actions

CONCLUSION

The results of the House of Risk model in managing 24 risk sources obtain 22 mitigation actions that are prioritized to be realized that are planning and conducting routine maintenance, annual shutdown / maintenance, 1-year contract with the customers, socialization the phone number of transporter PICs, preparing the buffer stocks, training on maintenance, improving the coordination among the departments, planning the production stock, coordination with the related parties, coordination with the transporters, daily briefing, routine and unscheduled briefing, coordination among the divisions before production, coordination with the environment, using the necessary chemicals, regular briefing before conducting the routine activities, coordination with the power plan, personal training on the raw material storing, saving the contact numbers of delivery PICs, improving the process of operational contour, coordination with the user to always be suited with the specifications, and updating the equipment and the latest models.

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SUGGESTION

Any future research that can be conducted in the perfection of this research can be conducted by identifying the risks that is not only limited on the type of operational risk but also other types of risk such as financial risk.

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