Development of Supply Chain Risk Mitigation in order to develop an effective strategy for Small and Medium Enterprises

by Siti Sujatini

Submission date: 12-Mar-2024 03:24PM (UTC+0700)
Submission ID: 2318456579
File name: Conference_Fullpaper_Henni_Revisi_Agustus_2023.docx (118.63K)
Word count: 5236
Character count: 28141

Development of Supply Chain Risk Mitigation in order to develop an effective strategy for Small and Medium Enterprises

Henni Henni[1], Diah Pramestari[2], Dwi Dinariana[3], Fitri Suryani[4], Siti Sujatini[1], Al Ikbal Arby[6], Jhonny ZA[7]

[1,2,6] Department of Industrial Engineering, Universitas Persada Indonesia YAI, Indonesia;
[3,4] Department of Civil Engineering, Universitas Persada Indonesia YAI, Indonesia
[5]Department of Architecture, Universitas Persada Indonesia YAI, Indonesia
[7]Department of Information System, Universitas Persada Indonesia YAI, Indonesia
[1] E-mail address henn1_bm@yahoo.com; [2] E-mail address mestadp@gmail.com;

Abstract

Supply chain risk management is the process of detecting, analyzing, and managing risks associated with a company's supply chain. Risk reduction is implemented throughout the supply chain of SME who manufacture character pillows, doormats, floor mattresses, and scouring pads. This company's supply chain has various issues, including variations in client demand, volatility in the number of products produced, and the company's failure to effectively oversee the supply chain, which results in decreasing quality and decreased customer satisfaction. The goal of this study is to use the Failure Mode and Effect Analysis (FMEA) approach to mitigate supply chain risk and develop solutions to minimize or eliminate supply chain risk with the highest RPN and risk score. The risk mitigation approach was employed in this study, with three stages: risk identification, evaluation, and risk analysis, as well as establishing a risk mitigation strategy. The FMEA approach of risk mitigation yielded the three highest RPN (Risk Priority Number) values of the 31 supply chain concerns. These three dangers are inaccuracies in the amount of products produced, consumer complaints against companies, and rapid changes in production orders. Our findings theoretically highlight the risks that arise in SME supply chain operations such as planning, sourcing, manufacturing, delivery, and return. Meanwhile, organizations can use the research findings to coordinate their supply chain plans.

Keywords: supply chain risk, small and medium enterprises, risk mitigation, Strategy, failure mode and effect analysis

I. INTRODUCTION

Small and Medium Enterprises (SME) play an important role in a country's industrial and economic domains. In Indonesia, the number of SMEs is expected to reach 64 million by 2020. According to Law No. 20 of 2008 on SMEs, SMEs are small businesses owned and managed by a single person or a small group of persons with a specific amount of wealth and revenue. CV. Bambu Jaya is a small and medium-sized enterprise (SME) in Penggilingan, East Jakarta. For a long time, the company has been creating character pillows, doormats, floor mattresses, and scouring pads and distributing them to the local market on the island of Java.

The company's supply chain problems include changes in customer demand that are often insufficiently responded to, the company's inability to effectively monitor the supply chain, which results in decreased quality and customer satisfaction, and the number of products produced is unstable each month due to machine breakdown, insufficient raw materials, and labor shortages in the production department. Mitigating risk in the supply chain can decrease, diminish, or even eliminate the supply chain's causes and risk events. This risk assessment can also be used to boost or stabilize output at CV. Bamboo Jaya.

The aim of this study is to use the Failure Mode and Effect Analysis (FMEA) approach to mitigate supply chain risk and develop solutions to minimize or eliminate supply chain risk with the highest RPN and risk score.

FMEA is a risk analysis method used to identify and avoid probable failures in a system, product, or process before they occur (Ceylan *et al*. 2023). The National Aeronautics and Space Administration was the first to use the FMEA technique in the aerospace industry in the United States (Bowles dan Peláez 1995). Experience in identifying and mitigating past risks can be translated into the capacity to foresee future hazards when using FMEA. Some possible risks can thus be avoided in the early stages of design. Because of the benefits of FMEA, it is widely employed in numerous industries, including aerospace, electrical, nuclear, health, and manufacturing.

Supply chain risk management is the process of detecting, analyzing, and managing risks associated with a company's supply chain. Supply chain risk management assesses risks at each stage of the supply chain, from suppliers to end users. Natural disasters, supplier inability to fulfill orders, rising raw material prices, information system breakdowns, and changes in government legislation are all potential supply chain risks. Disruptions in the supply chain harm the entire firm and the chain's overall supply. The supply chain is particularly exposed to risk due to its complex and diversified character.

Several scholars have recommended various risk mitigation measures in the upstream and downstream of the company's supply chain. One of the company's risk-mitigation techniques is an efficiency plan that decreases risk without affecting profitability.

II. LITERATURE REVIEW

Risk Mitigation

Risk mitigation is an action or strategy to reduce or avoid the impact that may arise from the identified risks, risk mitigation aims to reduce the possibility or impact of losses due to risk. Each risk has a different treatment; five types of treatment for risk, namely: a) avoid risks, b) transfer risks, c) reduce opportunities or the impact that occurs, d) accept the risk and e) mitigate. According to (the Australian/New Zealand Standard (2004) Risk is the likelihood that an unfavorable event will have an impact on a goal. Risk is commonly associated with negative outcomes such as loss, danger, and other consequences.

Various types of study have been undertaken, but risk mitigation research to preserve supply chain stability in SME that produce floor mattresses, cushions, pillows, sofabeds, and floor tapes has yet to be conducted. A great deal of risk mitigation research has been conducted. Risk mitigation research in the food business utilizing the SCOR and HOR methodologies is one of these studies. Traceability can handle 13 categories of traceability in the analysis of supply chain risk for apple cider drinks. With a weight of 140, one extreme risk is a shortage of items and raw materials in the warehouse. Traceability may handle up to 75% of the causes of risks; this demonstrates that the role of traceability in the food supply chain can lessen the risks that occur. Traceability can provide quick information to prevent, identify, and mitigate hazards in the food supply chain process (Handayani 2014). The findings revealed 30 risk occurrences at various phases of the doughnut supply chain process, as well as 11 risk reduction activities (Ulfah 2020). Furthermore, the House of Risk technique was applied in studies on supply chain risk mitigation in koi fish farming. The findings revealed 53 risk events, 33 causes, and ten planning goals for reducing risks along the supply chain flow (Aldimas *et al*. 2021). Another study identified six potential hazard modes in order to identify potential hazard factors, risk assessment, and risk reduction in engine room maintenance and repair work on general cargo ships.(Pratama dan Basuki 2022).

Supply Chain Risk Management (SCRM)

Supply Chain Risk Management (SCRM) is a combination of Supply Chain Management and Risk Management (Brindley, 2004), in which Supply Chain Risk Management interacts with supply chain partners to apply risk management processes.

Supply chain risks are divided into two types of risk, namely (Tang 2006):

1. Operational Risk is uncertainty originating from within the supply chain consists of uncertainties in demand, supply, and costs.
2. Disruption risk is the risk due to large-scale disturbances caused by nature and humans (such as earthquakes, floods, storms, attacks, terrorists, and so on) and economic crises (such as exchange rate devaluation).

The first step in estimating the risk of an occurrence is to categorize the risk. Chopra and Sodhi (2004) classified nine types of risks as follows: interruption, delay, system breakdown, forecasting, property wealth, intellectual property, procurement, accounts receivable, inventory, and capacity. According to Christopher and Peck (2003), the risks in the supply chain are classified into three types:

1. Internal risk is one of the risks the supplier company controls.
   a. Process risk is the risk that arises from operational activities and managerial due to disruption of a process.
   b. Control risk is the risk that arises due to errors in implementing company rules. For example, order size, safety stock policy, and transportation.
2. Risks external to the company but still within the supply chain network, including risks of demand and supply risk.
   a. Demand risk is the risk that arises due to disruption of product flow and information specifically related to processes, controls, assets, and downstream instructors.
   b. Supply risk is similar to flow disruption products and information specifically related to processes, controls, and upstream instructors.
3. Supply chain external risks include environmental risks.

   Environmental risks can affect both downstream and upstream processes. Environmental risks can result from natural disasters, political factors, etc.

There are nine strategies for dealing with disruptions in the supply chain(Tang 2006):

1. Postponement is a strategy to standardize products and processes design such as standardization, commonality, modular design, and operations reversal, to delay product differentiati
2. Strategy Stock, In keeping safety stock, the company should save inventory in "strategic locations (warehouses, logistics hubs, distribution centers) where the storage location can be shared with the supply chain partners
3. Flexible supply base. To guarantee smooth supply in the event of an interruption, it is necessary to have a flexible supply so that it can be easily changed between one supplier to another.
4. Make and Buy. A supply chain will be more resilient if several items are produced in-house and some other products are outsourced to suppliers.
5. Economic supply incentives. Provides economic incentives to assume the risk financial together and buy an unsold stock at a price low.
6. Flexible transportation. The smoothness of activities the supply chain is greatly influenced by flexibility in transportation can be done in three ways 1) Multi-modal transportation, 2) Multi-carrier transportation, 3) Multiple routes.
7. Revenue management via dynamic pricing and promotion. This strategy is perfect for perishable goods. Price changes and promotions may affect demand for consumers
8. Assortment planning. Change the appearance of the product and its placement on the shelves retailers to influence consumer interest and demand.
9. Silent product rollover. Launching new products quietly without giving a way formal announcement.

There are nine mitigation measures for mitigating supply chain interruptions, which are as follows: postponement, stock strategy, A supply base that is adaptable. Make and purchase. Economic incentives for supply. Transportation that is adaptable. Dynamic pricing and promotion are used to manage revenue. Planning the assortment. Rollover of a product that is completely silent.(Iryani Handayani 2016)

Failure Mode and Effect Analysis (FMEA)

FMEA (failure mode and effect analysis) is an organized technique for identifying and preventing as many possible failure modes. FMEA is used to identify the causes and sources of a quality problem. A failure mode is described as defect or failure in design, external conditions established specification limits, or modifications in that product that create disruption of the product's function.

FMEA (failure mode and effect analysis) is a structured technique for identifying and avoiding failure modes. FMEA is used to pinpoint the sources and underlying causes of a quality issue. The FMEA method was initially used for military reasons by the United States armed services in 1940. Later, when the United States was poised to send people to the moon for the first time, FMEA was utilized in rocket research to

avoid failures in rocket technology. This technology is being further developed for use in the automotive sector, such as Toyota, for security, regulation, higher production, and design. (Marimin *et al*. 2013).

Failure Mode and Effect Analysis is a systematic methodology that use a learning method to aid engineers in identifying likely failure modes and their consequences. Failures are classed depending on their impact on the mission success of a system. FMEA attempts to identify and avoid disruptions by identifying potential risks and establishing solutions to mitigate those risks. Three factors will aid in assessing the failure's priority: severity, occurrence, and detection.

The steps for making FMEA are as follows:

1. Description of the product or process and its functions
2. Make a block diagram
3. Create an FMEA form,
4. List the items or functions using the FMEA diagram.
5. Identify potential failures
6. List any technical failures for the function of each component or process steps.
7. Describe the effect of the causes of each failure, according to consumer perceptions.
8. Identify the cause of each failure.
9. Determine the probability factor, namely numerical weighting, for each cause that often occurs.
10. Rating on a scale from 1 to 5, where one represents infrequently, and five indicates frequently.
11. Identify existing controls, namely mechanisms capable of detecting failures before they reach the consumer.
12. Determine the likelihood of Detection.
13. Review Risk Priority Number (RPN), which results from multiplying the occurrence; frequency of errors, Severity variables; seriousness due to errors in the process, Detection; control tool for potential causes.
14. Define recommendations for potential failures that have a high RPN.

III. METHODOLOGY

This section discusses the research methodology, which is separated into three stages, as illustrated in Figure 1. The first stage of risk identification is to identify potential risks in the supply chain. The risks to be reviewed include supply chain hazards that might affect firm performance, with risks classified as plan, source, make, deliver, and return. The second stage is risk analysis and evaluation, which involves conducting an impact assessment to determine which hazards must be handled first. The final stage of establishing a risk mitigation strategy is a plan to lessen the impact of risk or the likelihood of the risk occurring.

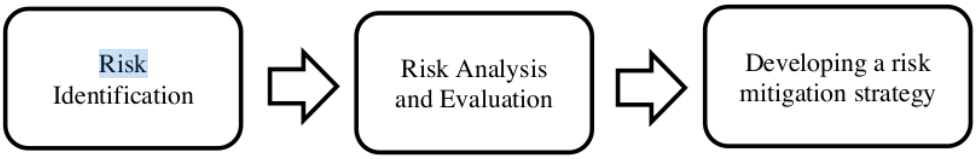

Fig. 1. The Methodological Procedures

Data Collection

The first data used in this study is risk data that may occur along the supply chain obtained from interviews with company management and literature studies. The second data was obtained from filling out a risk questionnaire for incidence, severity, and detection factors by three experts (1 academician and two managers at the level) and a team of three observers (3 workers).

The results of interviews with company management related to risks in the supply chain management process found that 35 risks were sorted for risks that had the same meaning and avoided ambiguity for 35 risks to obtain 31 risks.

The questionnaire consists of three risk variables: probability, impact, and detection. This questionnaire was filled out by three experts and a team composed of three observers, and the respondents were selected based on the position, level of expertise, type of work, or length of employment. Each identified risk is assessed for the probability of occurrence and the resulting impact if the risk occurs and detects the failure.

Data Analysis

Referring to the methodological procedures used, the data analysis in this study includes risk identification, risk analysis, and evaluation with the FMEA approach and developing a risk mitigation strategy.

Risk Identification

For the risk identification process, it is necessary to study the entire supply chain to find critical values or activities in the supply chain, which can be processes, systems, or production activities. Then a list of possible risks is determined and classified in the plan, source, make, deliver, and return group. The next step is filling out the questionnaire from the list of risks that may occur, determining the value of the occurrence factor; frequency of occurrence of errors, severity factor; seriousness caused by errors in the process, Detection; control tools to determine potential causes,

Risk Analysis and Evaluation

Risk weighting

This weighting is carried out about the existing risk groups. Both teams and experts are given a weighting of 0.5. This weighting is carried out because the expert respondents are experts in their field, while the assessment by the team is based on discussions by observers who also have a stake in seeing the risks involved.

Risk Priority Number (RPN)

A numerical method is used to evaluate risk based on a combination of three factors: severity, the likelihood of occurrence, and the likelihood of detection of a chance. RPN values indicate the relative importance of a risk in a particular context.

The RPN value is used to prioritize risks by highlighting the risks that have the highest RPN values. Risks with a high RPN value indicate risks that have a potentially severe impact, a high probability of occurrence, or a low ability to detect or control these risks.

A Risk Priority Number (RPN) is a mathematical system that translates a set of effects with a severe level of severity to create a failure related to these effects (occurrence) and can detect failures (detection). before reaching the consumer. The risk priority number is obtained by mathematically multiplying the O, S, and D inputs scored by the experts. This calculation is demonstrated in Eq:

RPN=O x S x D

Risk Score

A risk score is a number or value assigned to a risk to indicate its level of importance or group of associated risks. Generally, the risk score is calculated by combining the two main dimensions: the impact and likelihood of the risk occurring. The effect refers to the level of negative consequences or results that may occur if a change occurs, while possibility refers to the probability or frequency of occurrence of a risk.

The risk score is is obtained by mathematically multiplying the O, and S inputs scored by the experts. This calculation is demonstrated in Eq:

Risk Score =O x S

Developing a risk mitigation strategy

Consist on the strategy is determined from the results of the highest RPN value and risk score, then brainstorming and analysis are carried out.

IV. RESULT AND DISCUSSION

The results of Risk Identification

The initial step in this risk identification stage is to investigate the organization's business operations from upstream to downstream using company records. Following the responsibilities and obligations of the division related to the supply chain management done by the organization, each flow from one section of the division to another includes possible dangers. Then, examine the risks to the company using the literature gathered from expert interviews, questionnaires filled out by experts and a team of three observers, and internet journals indicated in chapter two. These are risks that affect the flow of information and products from upstream to downstream in each company's business operation. The risks to be examined are focused on risks in supply chain management that can affect the company's processes in carrying out its business after conducting interviews with experts and operationalists in the field using the checklist form, so that there is a concentration of factors that facilitate risk identification. These are risks that affect the flow of information and products from upstream to downstream in each company's business operation. A list of 31 dangers in the supply chain that could occur in the organization was obtained by conducting interviews with experts and personnel using the checklist form. As can be seen in table 1. Meanwhile, table 2 shows the classification of risks in the plan, source, make, deliver, and return groups:

Table 1. Supply chain risk

Code	Risk
E1	Lack of material availability
E2	Inappropriate production equipment maintenance planning
E3	Miscommunication in interpreting information
E4	Rapid changes in production orders
E5	Government regulations do not support
E6	Obstruction of information systems such as internet, telephone
E7	Supplier is late in delivery
E8	The material sent does not match the amount
E9	The quality of the material sent is not up to standard
E10	Problematic agreements or contracts with institutions
E11	Difficulties in obtaining appropriate supporting materials and packaging materials
E12	Raw materials from suppliers who are not available in terms of quality
E13	The production machine is damaged
E14	Prices increased suddenly
E15	Insufficient experts
E16	Work accident
E17	Worker negligence
E18	Uncertain production costs
E19	Inaccuracies in the amount of products produced
E20	Occurrence of natural disasters
E21	Inventory of finished products that have piled up
E22	The expedition was late picking up the goods
E23	Delivery of goods from CV. Bambu Jaya to consumers late
E24	Disrupted product transportation
E25	Product delivery does not match the quantity
E26	The product was damaged during delivery
E27	Decreased consumer satisfaction
E28	inflation increases
E29	There was a natural disaster when returning
E30	There was an accident while returning
E31	Consumer complaints against companies

Table 2. Supply chain risk grouping

Risk Group	Count & Risk Code	Percent	Cum (100%)
Plan	6 (E1,E2,E3,E4,E5,E6)	19%	19%
Source	6 (E7,E8,E9,E10,E11,E12)	19%	39%
Make	9 (E13,E14,E15,E16,E17,E18,E19,E20,E21)	29%	68%
Deliver	5 (E22,E23,E24,E25,E26)	16%	84%
Return	5 (E27,E28,E29,E30,E31)	16%	100%
Total	31	100%	

The make-based risk distribution has the highest percentage, 29%. The high value of the make % is due to the type of company investigated, which is a manufacturing company with added value in every phase of the manufacturing process until it becomes a product. Furthermore, the firm's management arrangements affect a number of processes within the company, resulting in comparatively larger risks when compared to other risk groups.

The results of Risk Analysis and Evaluation

Weighting on the results of the questionnaire filled out by three experts and a team of observers by multiplying by 0.5 while the results can be seen in Table 3

Table 3. Supply chain risk weighting

Code	Risk	Total Probability	Total impact	Total Detection
E1	Lack of material availability	1	1	3
E2	Inappropriate production equipment maintenance planning	2	1	2,5
E3	Miscommunication in interpreting information	2	1	3
E4	Rapid changes in production orders	2,5	1,5	2,5
E5	Government regulations do not support	1	1	2,5
E6	Obstruction of information systems such as internet, telephone	1	1	2,5
E7	Supplier is late in delivery	1,5	1,5	2
E8	The material sent does not match the amount	1	1	3
E9	The quality of the material sent is not up to standard	1	1	2,5
E10	Problematic agreements or contracts with institutions	1	1	2,5
E11	Difficulties in obtaining appropriate supporting materials and packaging materials	1	1	3
E12	Raw materials from suppliers who are not available in terms of quality	1	1	2
E13	The production machine is damaged	1,5	2	3
E14	Prices increased suddenly	1,5	1	3
E15	Insufficient experts	1	1	3
E16	Work accident	1	1	3
E17	Worker negligence	1	1	2
E18	Uncertain production costs	1,5	1,5	2,5
E19	Inaccuracies in the amount of products produced	2,5	2,5	2,5
E20	Occurrence of natural disasters	1	1	2
E21	Inventory of finished products that have piled up	1	1	2,5
E22	The expedition was late picking up the goods	1	1	2,5
E23	Delivery of goods from CV. Bambu Jaya to consumers late	1,5	1	2,5
E24	Disrupted product transportation	1	1	3
E25	Product delivery does not match the quantity	2,5	1	3
E26	The product was damaged during delivery	2	1,5	2,5

E27	Decreased consumer satisfaction	1	1	3
E28	inflation increases	1,5	1	2,5
E29	There was a natural disaster when returning	1	1	2
E30	There was an accident while returning	1	1	2,5
E31	Consumer complaints against companies	3	1,5	3

To determine the risk priority number (RPN) value and risk score on supply chain risk can be seen in table 4 below

Table 4. The risk priority number (RPN) and risk score

Code	Risk	Risk Priority Number (RPN)	Risk Score
E1	Lack of material availability	3	1
E2	Inappropriate production equipment maintenance planning	5	2
E3	Miscommunication in interpreting information	6	2
E4	rapid changes in production orders	9,38	3,75
E5	Government regulations do not support	2,5	1
E6	Obstruction of information systems such as internet, telephone	2,5	1
E7	Supplier is late in delivery	4,5	2,25
E8	The material sent does not match the amount	3	1
E9	The quality of the material sent is not up to standard	2,5	1
E10	Problematic agreements or contracts with institutions	2,5	1
E11	Difficulties in obtaining appropriate supporting materials and packaging materials	3	1
E12	Raw materials from suppliers who are not available in terms of quality	2	1
E13	The production machine is damaged	9	3
E14	Prices increased suddenly	4,5	1,5
E15	Insufficient experts	3	1
E16	Work accident	3	1
E17	Worker negligence	2	1
E18	Uncertain production costs	5,63	2,25
E19	Inaccuracies in the amount of products produced	15,63	6,25
E20	Occurrence of natural disasters	2	1
E21	Inventory of finished products that have piled up	2,5	1
E22	The expedition was late picking up the goods	2,5	1
E23	Delivery of goods from CV. Bambu Jaya to consumers late	3,75	1,5
E24	Disrupted product transportation	3	1
E25	Product delivery does not match the quantity	7,5	2,5
E26	The product was damaged during delivery	7,5	3
E27	Decreased consumer satisfaction	3	1
E28	inflation increases	3,75	1,5
E29	There was a natural disaster when returning	2	1
E30	There was an accident while returning	2,5	1
E31	Consumer complaints against companies	13,5	4,5

The results of Developing a risk mitigation strategy

According to the RPN value and risk score, the three risks with the highest values are inaccuracies in the amount of products produced (E19), consumer complaints against companies (E31), and rapid changes in production orders (E4).

The first risk is inaccuracies in the amount of items produced, which result in an excess or lack of product supply, which has an impact on production costs. This risk happens once every 6 - 9 months, causing a 10% - 20% reduction in product flow. The second danger is that there are consumer complaints about the company. This risk can be used to assess consumer satisfaction with the company's products and services. This risk arises only once every 6-9 months. If this danger arises, the product flow will be disrupted, with a 5% - 10% presentation. Sudden fluctuations in production demand are the third risk. This risk is related to the company's ability to meet the unexpected demand. This risk arises only once every 9-12 months. The consequence of this risk can cause a 5% reduction in product flow.

To discover the elements influencing the three hazards with the greatest RPN value and risk score, which are errors in the number of products produced, consumer complaints to companies, and unexpected changes in production requirements. The company was then involved in a brainstorming session, which was then further evaluated to determine the factors that influence the three risks, namely; First, there is no accurate forecast of demand; second, there is no periodic checking of demand data; third, there is no checking of finished goods before distribution; fourth, there is no checking of finished goods inventory; and finally, there is no periodic machine checks at the company. Will take activities to correct the risk based on the highest risk obtained. Table 5 shows the risks and corrective strategies.

Table 5. The risk and corrective action

No	Risk	Corrective action
1	Inaccuracy is in the number of products produced	This production quantity inaccuracy is the result of an error in calculating the number of product requests, so it is critical to routinely check the accuracy of sales data and forecast the precise demand.
2	Customer complaints against businesses	Quality control in all production lines, as well as product inspection before distribution, must be improved.
3	Rapid changes in production orders	To meet unexpected requests in insufficient numbers, raw material and finished product inventory must be periodically checked.

V. CONCLUSION

The following are the findings of this study: The risks that arise in the supply chain of enterprises that manufacture character pillows, doormats, and floor mattresses total 31 dangers, which are divided into five categories: plan, source, make, delivery, and return. The three most significant risks, based on the value of the risk priority number and risk score, are: the first inaccuracy is in the number of products produced. The second category includes customer complaints filed against businesses. Finally, production demand shifts abruptly.

Strategies for reducing or eliminating these risks include: 1) more accurate product demand forecasting, verifying demand data on a regular basis, and 2) Investigate client concerns and make modifications to achieve high consumer satisfaction. 3) Before items are given to merchants or consumers, enterprises must boost inspection of finished products so that sufficient stock may be prepared to meet strong demand. 4) Inventory checking of raw materials and completed goods must always be performed in order to fulfill sudden product demand. 5) Engine maintenance and inspection must always be performed in order to preserve engine performance.

VI. LIMITATIONS & FURTHER RESEARCH

Although the FMEA approach can be utilized to efficiently manage supply chain risks, this study is limited to one small medium enterprise. The FMEA approach is used exclusively in this study to design risk mitigation strategies in SME that manufacture character pillows, doormats, floor mattresses, and scouring pads. To achieve efficient and high profitability SME, future research must investigate the optimum supply chain risk management development model.

ACKNOWLEDGEMENT

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