Establishing Risks of Food Supply Chains for Small and Medium Food Manufacturing Companies in Malaysia

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Abstract

The supply chain is a network that involves organizations, resources, activities and technologies in the creation and sale of products, from suppliers of raw materials to subsequent manufacturers to consumers through delivery. However, supply chains are often vulnerable to risk of uncertainty. Risk in the supply chain is the exposure to the occurrence of a loss or injury that would affect the overall supply chain of the supply chain. In this study, the supply chain is assessed through analysis of the risks occurring in the supply chain in the real industry. The purpose of this study is to identify the existing risks in the supply chain in the food manufacturing industry in Malaysia. This study was conducted through interviews and questionnaires. Information and data obtained are used for risk analysis to identify the types of risks encountered in the supply chain through the Analytical Hierarchical Process Technique (AHP) method. In conclusion, the risk analysis in the supply chain can determine the highest risk types in the supply chain which is the risk of competition among companies (53%) and factors that cause such risks are competition from other manufacturers (86%) as well as market entry (14%). Furthermore, measures to overcome and mitigate these hazards can be carried out once risks are identified.

Keywords

Food Supply Chain, Risk of Supply Chain, Food Manufacturing, Analytical Hierarchical Process (AHP) and Risk Analysis.

1. Introduction

According to Absi et al. (2013), current industrial growth is increasingly affecting the future sustainability of the earth and its natural resources and environment. To address such concerns, human beings should be responsible for developing environmentally friendly activities efficiently and effectively. SCM activities, which are a variable of social life today, are fundamental to that responsibility. This is supported by Heckmann et al. (2014). It is stated that supply chain management is aimed at planning, monitoring and controlling the organizational chain so that the various types of flows between the original producer and the end customer can be interdependent with each other. Next, be able to maximize profits through efficiency as well as customer satisfaction.

However, today's supply chains are increasingly vulnerable to potential risks in the supply chain (Son and Orchard 2013; Zsidisin and Wagner 2010). Risks in the supply chain will become more frequent if not addressed and also involve high costs. However, by identifying the types of risks as well as risk factors, risk mitigation plans can be put in place to increase opportunities and reduce threats to SCM. According to Kamalahmadi and Parast (2017), one of the risk factors in SCM is that suppliers are interdependent with each other, where disruption in one provider can disrupt another active provider.

Furthermore, the supply chain is more vulnerable to risk due to several factors namely globalization of resources, increased competitiveness as well as upon the occurrence of internal and external risk events such as material shortages

and natural disasters (Taylor et al. 2015). Hence, this study focuses on risks in the supply chain. This is because by knowing the risks faced in the supply chain, risk mitigation plans can be designed to reduce and eliminate the risks that cause failure as well as achieve goals in the supply chain.

1.1 Objectives

The purpose of this research is to identify the risks that are faced by the SME industry in Malaysia by assessing their regular problems that occurred.in order to achieve the aim of the study, the following objectives were defined:

1. Choose the existing framework to be adapted for and serve as the fundamental for the research.
2. Develop a research instrument (i.e. questionnaire) to investigate the risks.
3. Identify the factors that contribute to the risk s in food manufacturing companies.

2. Literature Review

2.1 Risks in the Supply Chain

The need for effective supply chain risk management (SCRM) is further emphasized in global supply chains where the distance between suppliers and markets is often greater and the commercial environment more complex than in the domestic supply chain (Wu et al. 2013; Blackhurst et al. 2011). The profound impact of supply chain disruptions was illustrated in March 2011 when a strong earthquake in Tohoku, Japan affected the flow of the global automobile industry (Fujimoto 2011). The Japanese automaker's domestic assembly line has been closed for about a month and shortages related to automotive electronic sensors caused by problems at Hitachi's Automotive Systems plant in Tohoku led to temporary suspensions or reductions in vehicle production in Germany, Spain, France and the United States (Supply Chain Risk Leadership 2011).

Sodhi and Tang (2018) stated that SCRM is a multidisciplinary area with research and practice covering supply chain management (SCM), enterprise risk management which includes supply risk, business continuity, which in turn provides sustainability risk and crisis management. In addition, according to Hishamuddin (2013) risk has been classified into four categories: (i) risk in production, (ii) supply risk (iii) transportation risk and (iv) fluctuations in demand. Production risk includes any form of disruption in production that may be due to material shortages, damage to machinery and availability, or any form of disruption. Transportation risk includes any form of disruption in the transportation system that may be caused by vehicle damage, road works, strikes, and natural disasters such as earthquakes and floods. Finally, fluctuations in demand can be defined as any type of variation in the demand for a final retailer’s product. Demand can increase or decrease for a certain of time. Risk in the supply aspect is defined as the possibility of failure in the supply of goods in terms of time, quality and quantity resulting in incomplete ordering. Risk in the manufacturing process aspect can be defined as the possibility of unexpected things happening while producing the desired quality and quantity at the right time (Saeed and Kersten 2019).

Today’s supply chains are increasingly vulnerable to the possibility of destructive supply chain disruptions (Son et al. 2013; Zsidisin et al. 2010), due to their natural size, dynamic, and complex nature as well as rising customer demands and expectations (Ponomarov and Holcomb 2009). The increasing risks faced by companies are in terms of supply disruptions, production and delivery delays which ultimately result in companies losing reputation, loss of sales financial performance and deteriorating financial performance (Sreedevi and Saranga 2017). Lockamy and McCormack (2010) explained that disruption risks are linked to conditions such as natural disasters, terrorist attacks and strikes by labor as well as lack of coordination between supply and demand. While Thun et al. (2011) state that operational risk is internal supply chain risk. In addition, (Sreedevi and Saranga 2017) noted that uncertainties in market demand related to innovative products that have shorter life cycles will affect the level of accuracy of demand forecasts and related inventory levels. Uncertainty in demand, manufacturing and the supply environment has the potential to impact delivery quality and reliability in terms of delivering correct and timely products. Therefore, firms operating in an uncertain environment are more prone to delivery failure.

2.2 Small and Medium Enterprises (SMEs)

According to Hilmi et al. (2010), SMEs in Malaysia there is more than one definition. The definition of SMEs in Malaysia is explained in Table 1 and Table 2 below. However, different definitions are used in other countries. In Malaysia, various agencies provide their own interpretations of SMEs. The definition differs in terms of several factors such as the number of full-time employees or sales turnover figures and is generally defined into two broad categories.

One of these categories includes manufacturing, manufacturing-related services and agro-based industries and the other categories include services, primary agriculture and information and communication technology.

Table 1: Definition of SMEs Based on Sales Revenue as Published in the 2015 SME Performance Report

Size	Manufacturing (including agro-based) and manufacturing-related services	Service sectors include ICT and major agriculture
Micro	Less than RM 250,000	Less than RM 200,000
Small	Between RM 250,000 and less than RM 10 million	Between RM 200,000 and less than RM 1 million
Medium	Between RM 10 million and RM 25 million	Between RM 1 million and RM 5 million

Table 2 Definition of SMEs Based on Full-time Jobs as Published in SME Performance Report 2015

Size	Manufacturing (including agro-based) and manufacturing-related services	Service sectors include ICT and major agriculture
Micro	Less than 5 employees	Less than 5 employees
Small	Between 4 and 50 employees	Between 5 and 19 employees
Medium	Between 51 and 150 employees	Between 20 and 50 employees

Next, according to Lan et al. (2014), a company is defined as an SME if it has less than 250 employees. Kaur et al. (2018) noted that in addition to the size of the measure, independence from large enterprises is another key feature of SMEs, where ownership of only a small number of companies is allowed by larger enterprises. Furthermore, (Nicholas and Fruhmann (2014), also noted that similar criteria have been used by the US Small Business Association to classify SMEs. However, due to rapid developments in the economy, such as price inflation, structural changes and changes in business trends, the previous definition of SME was revised and formally adopted in 2013. SMEs are now defined as manufacturing firms whose sales turnover does not exceed RM50 million or with a workforce not exceeding 200 full -time employees, an agricultural firm is defined as having a sales turnover not exceeding RM20 million or a workforce not exceeding 75 full -time employees (SME Corp Malaysia 2018).

Based on Musa and Chinniah (2016), small and medium enterprises (SMEs) play an important role in the Malaysian economy and are considered to be the backbone of industrial development in the country. SMEs in Malaysia are on track to contribute 41% to the country's GDP by 2020 compared to 32% in 2012, and local SMEs are now suppliers to multinational companies (MNCs) in the global network. According to Hashim (2015), the contribution of SMEs to a country’s economy has been recognized in developing countries and its impact can be seen in income growth, entrepreneurship training, technological capacity creation, greater flexibility in changing market conditions, job creation, wage injustice lower and the spread of industry away from urban areas and regional development. In turn, SMEs involved in the global market have an advantage on international and domestic platforms.

Furthermore, in 2012, SMEs contributed almost 33% of Gross Domestic Product (GDP) and almost 60% of total employment (SME Corp Malaysia 2018). Moreover, (Walker and Preuss (2008) state that there is hope that SME participation in public procurement can foster the achievement of political goals such as sustainability. Thus, the promotion of SMEs is one of the special political aspects attached to the proper procurement task in public procurement legislation and institutions (Kidalov and Snider 2011). According to Abu et al. (2013), SMEs have different characteristics compared to large organizations. SMEs have limitations in terms of knowledge, resources, experience and skills to be more innovative. Jorgensen and Knudsen (2006) also noted that SMEs are likely to lack the resources and bargaining power needed to implement sustainability standards in their own suppliers.

Furthermore, according to Lindgren (2012), SMEs are still given less attention in public-private supply relations, even though they are very important for national and regional economies and also even though legislation in many countries has implemented SME support measures, such as implementing national legal action. in each European Union (EU) member state in response to public procurement directives, there is still no adequate understanding of the factors driving successful SME participation in public procurement.

Nicholas and Fruhmann (2014), refer to data on SME participation in public procurement and show that SMEs award smaller contracts and contracts of lower value compared to the proportion of SMEs in the business sector. However, the conclusion that this allows calls for further breaking of contracts to be more to support the success of SMEs is far -fetched. Although the assessment of the actual impact of SME support measures has been a recent contribution topic, there is still limited empirical evidence on what and how legislation supports between public buyers and private SMEs (Musa and Chinniah 2016). The internationalization of SMEs has expanded following technological developments, market deregulation, world trade liberalization and the emergence of regional economic cooperation agreements. Advances in telecommunications and technology have made it easier for SMEs to engage in the global market through cost and risk reduction.

3. Methods

Method used for the study is case study at the chosen companies and the data is analysed by using AHP method. Several steps have been taken to conduct this study, among the steps is to get two companies in the food sector to be studied. Next, is data collection and data analysis. Both of these aspects need to be well planned to avoid any problems in obtaining the correct results of the study and it runs smoothly. Figure 1 shows the flow chart for the research method to be conducted.

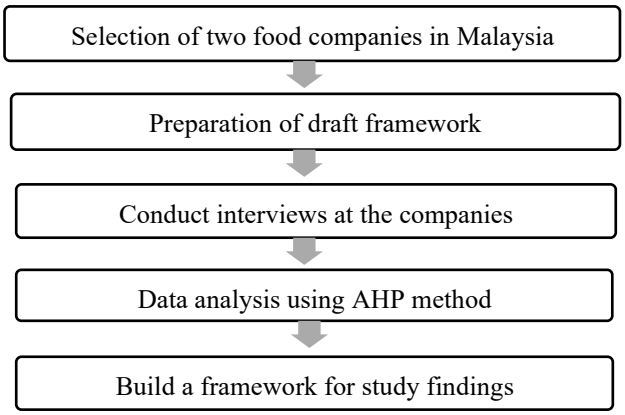

Figure 1: Flowchart Research Method

3.1 Case study

Case study is used as a research method because according to Shapiro (1986), case study method helps in making direct observations and collecting data in a natural setting, compared to the data that has been processed. Furthermore, Hollweck (2016) explains that the advantage of the case study method is the ability to redefine "cases," after collecting some preliminary data. Next, Brooks (1996) states the two main uses of case studies are to obtain descriptions and interpretations from a variety of perspectives. In addition, according to Yin et al. (2014), case studies relate to research strategies that focus on the questions of 'who', 'why', or 'what'. Thus, it can be concluded that case studies allow a comprehensive research on a phenomenon to identify these characteristics.

Denzin and Lincoln (2013) have explained that case study methods are important when research needs to address descriptive questions such as what happened, as well as explanatory questions such as how or why something happened. Case studies are not limited to one data source, as in the use of questionnaires to conduct survey studies. In fact, good case studies benefit from having multiple sources of evidence. Common sources of evidence in conducting case studies are such as documents (newspaper articles and letters), archival records, interviews, direct observations and others (Yin et al. 2014).

3.2 Analytical Hierarchy Process (AHP)

Saaty (1985) has developed the Analytical Hierarchy Process (AHP) methodology, which is a powerful tool in solving complex decision problems. According to Nakatani and Chuang (2011), AHP was developed by Saaty (1985) as an approach in multi-criteria decision making. It is designed to help decision makers select the best alternatives that are evaluated against a number of criteria, which may be qualitative in nature or may not be directly measurable. Further, the applicability of AHP to results has been demonstrated by several studies (Massaeli et al. 2011). AHP can not only

be used for individual decision-making, but also a group decision -making environment. Furthermore, AHP has been widely used in various fields such as economics, politics, social, technological environment (Satty 1994) and problems (Massaeli et al. 2011). Figure 2 shows an example of an AHP process flow chart.

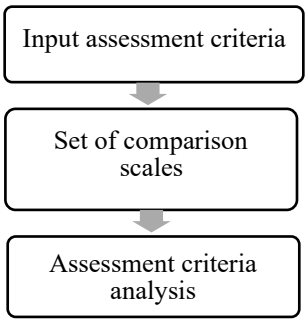

Figure 2 AHP Process Flow Chart

According to Wang and Chin (2011), AHP helps analysts organize critical aspects of a problem into a hierarchical structure similar to a genealogical form. By reducing complex results to a series of simple comparisons and rankings, then synthesizing the results, AHP not only helps analysts to achieve the best results, but also gives them a clear rationale for the choices made. Based on Saaty (1985) in general, a hierarchical model for some societal problems may be one that descends from the focus (overall objective), to the criteria, down further sub-criteria which are subdivisions of criteria and finally to the alternatives for which choices are made.

Based on Saaty (1985), AHP consists of several steps and is summarized as below:

(1) Explain clearly the goal of the decision, i.e. the hierarchical level.
(2) Identifying the criteria against the evaluated alternatives to achieve the goals and criteria is the second stage of the hierarchy.
(3) Identify sub-criteria, if any, for each of the criteria identified in step 2 and place them at the 3rd, 4th, and other hierarchical levels.
(4) Place alternatives to be evaluated at the bottom of the hierarchy.
(5) Construct a criterion / sub -criterion goal comparison matrix with respect to the next higher level goal / criterion, and assign numerical values on a scale ranging from one to nine, as shown in Table 1, to reflect the importance of each criterion in relation to the others to the goal. Calculate the weight of the criteria by normalizing a good pair comparison matrix and obtain an eigenvector.
(6) Construct a set of alternative-wise pair comparison matrices with each sub-criterion at the next higher level and provide a scale ranging from one to nine to show how much each alternative contributes to each sub-criterion relative to the other alternatives. Calculate the alternative contribution level by normalizing a good pair comparison matrix and obtain the eigenvector.
(7) Use the above matrix to construct a matrix, in which the number of rows equals the number of alternatives and the number of columns equals the criteria, to measure how well each alternative meets each of the result criteria.
(8) Calculate the total value of the weight for each alternative. The person with the highest score is considered the best option.
(9) Calculate the consistency ratio (CR) to ensure consistency of judgments about wise pair comparisons.

Figure 7 below shows one example of a hierarchical structure:

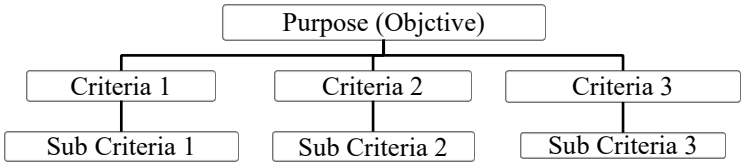

Figure 7 Examples of Hierarchical Arrangements
Source: *Saaty (1986)*

According to Saaty (1985), the basis in the use of AHP is the comparison of pairs. Table 3 explains the meaning of each priority scale and describes each priority scale of importance before making a pair comparison.

Table 3 Table of Pair Comparison Scales to Evaluate the Criteria

Priority if importance	Definition	Description
1	Equally important	Two activities contribute equally to the objective
3	Moderately important	Experience and evaluation are slightly in favor of one activity over another
5	Strong importance	Strong experience and evaluation in favor of one activity over another
7	Very strong or shows importance	One activity is highly favored over another activity, a practice that nominates other practices
9	The importance of extremes	Evidence in favor of one activity over another activity with the highest assertion
2,4,6,8	The intermediate value between two adjacent considerations	When a consensus is needed
The connection above		
1.1 -1.9	If the activities are closely related	It may be difficult to determine the best value but when compared to different activities, a small number of size values will not be significant. Yet, it can still show the relevance of the importance of the activity.

Source: *Saaty (2000). Basic decision making and priority theory with hierarchical process*

According to Satty (1994), when developing an AHP hierarchy, it is important to "include sufficient details to represent the problem as best as possible, but not so thorough as to lose sensitivity to changing elements". Furthermore, according to Massaeli et al. (2011), AHP has the following advantages:

1) it provides a systematic approach to quasi -quantitative structuring of qualitative problems
2) it helps decision makers or a group of decision makers to reach agreement on decisions by entering their preferences for decision criteria; and
3) it provides metrics to assess the consistency of decision makers' assessments of decision criteria and alternatives.

4. Data Collection

The open ended questionnaire was built from the extensive literature review. Then, it was pre-tested by two senior managers from the organizations chosen for the case study. Observations and interviews were conducted at the companies. The questionnaire was shared with the interviewees before the interview. It was for the preparation and gathering necessary information by the interviewees. The purpose of the study also was informed to all the respondents. Interviews, direct observation, documentation and archival records were the sources of the data collection. The quantitative data was also collected to verify the findings as most of the data were qualitative in nature.

5. Results and Discussion

5.1 Background information of two organizations

In this case study, Companies A and B are small and medium industrial status companies (SMEs) of small size. Looking in terms of the definition for this category, companies A and B have an estimated number of employees from five to less than 30 employees in the company. These companies also have annual sales from RM 300 thousand to less than RM 3 million.

The two companies that have been used as a study are located around Kelantan. Company A is a company that produces serunding products as its main product. The serunding is the meat floss and it can be mixed with grated coconut or not. Company A has been in operation for 15 years, during which time it is a family-inherited business. The type of serunding produced consists of fish, chicken and meat serunding. Company A has four to eight employees. During the festive season company A has more employees due to high demand from customers. Figure 4 shows the factory area of company A.

Figure 4: Factory Area of Company A

Company B is a company that produces budu. It is also known as sauce, which is traditionally made by mixing anchovies and salt in a ratio ranging from 2:1 to 6:1 and allowing the mix to ferment for 140 to 200 days. Company B has been in operation for 25 years. Company B's business is also a family -inherited business. Company B has eight employees working from 8.30am to 6pm. Budu packaging is done in two sizes, namely small size (290ml) and large size (320ml). Figure 5 below is the factory area of Company B.

Figure 5: Factory Area of Company B

5.2 Case Analysis of two organizations using AHP

The case analysis was conducted to analyse the risks that occur in companies A and B. The risks that occur in the supply chain network in Companies A and B are analysed using the Analytical Hierarchical Process (AHP) method. AHP is used for determine the types of risks that occur in both companies and the factors that contribute to each risk that occurs. By using AHP, the most important type of risk among the types of risk that occur in the two companies can be obtained, in turn can determine the type of risk which should be given priority so that measures to reduce risk can be taken. The steps of AHP calculation begin with the development of hierarchical criteria. The hierarchical criteria for this study are as shown in Figure 6 below.

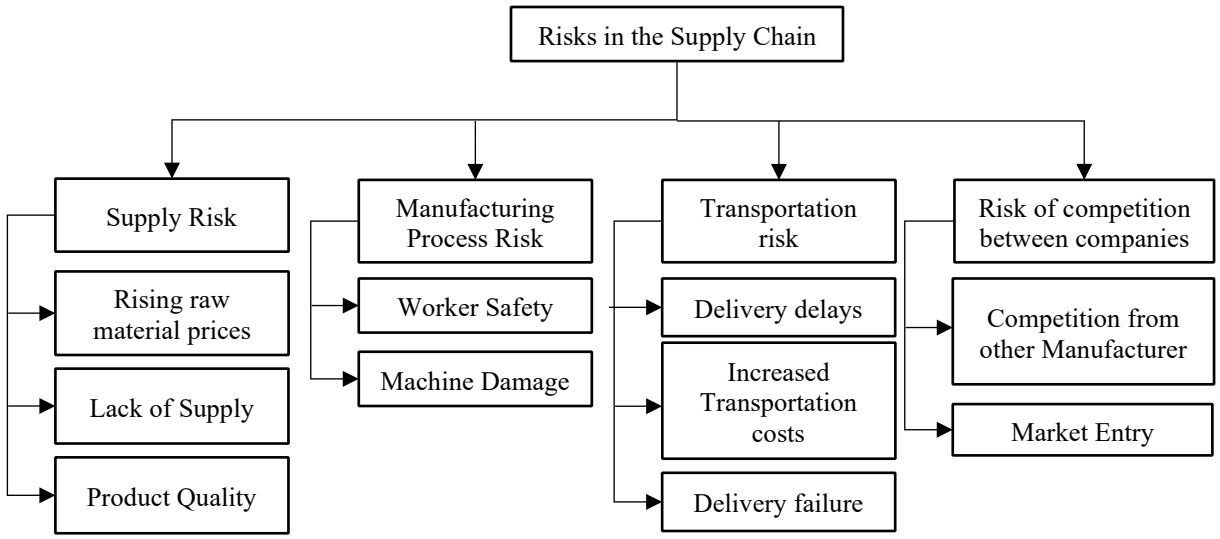

Figure 6: Hierarchical Criteria

After the development of the hierarchical criteria, a set of paired comparisons was constructed. Next, a consistency analysis was performed. In the consistency analysis, the consistency index and the consistency ratio were calculated. The consistency ratio must be less than 0.10. This is due to ensure that the original priority assessment is consistent. The calculation of AHP for the type of risk and the factors contributing to each type of risk occurring in companies A and B is included in the appendix.

The results of the study for risk occurring in the supply chain network in companies A and B using AHP method, pair comparisons were done to obtain the relative weight of the sub-criteria under each criterion and the results of the study are in Table 4.

Table 4 : Criteria and sub-criteria by weighting

Criteria	**Sub-criteria**
Risk of competition between companies (0.53)	Competition from other manufacturers (0.86) Market entry (0.14)
Supply risk (0.21)	Rising raw material prices (0.50) Lack of supply (0.25) Supply quality failure (0.25)
Manufacturing process risk (0.21)	Workers' safety (0.75) Machine breakdown (0.25)
Transportation risk (0.05)	Increased transportation cost (0.58) Delivery delay (0.31) Delivery failure (0.11)

In Table 4, the criteria or types of risks that occur in the SME food manufacturing industry in two companies namely companies A and B in terms of inter-company competition risk, supply risk, manufacturing process risk and also in terms of transportation risk are analyzed. As a result of the analysis, it can be seen that the type of competition risk between companies is a concern to these companies to continue business. Factors that contribute to risk are competition from other manufacturers which is very important from market entry for the risk of competition between companies.

Supply risk is the second type of risk that impacts these food manufacturing companies where rising raw material prices are the highest contributing factor to supply risk followed by supply shortages and supply quality failures.

Manufacturing process risk is the third type of risk that occurs in companies A and B. The factor that records a high value in this risk is the factor of employee safety because the food manufacturing process in companies A and B involves high temperatures that can cause injury to employees. emphasized and if workers do not wear safety equipment as directed and followed by machine breakdown.

As for transportation risk, the factors that cause the risk are the increased cost of delivery, delivery delays which are often caused by bad weather and also delivery failure factors.

5.3 Proposed Improvements

There are several suggestions that can be made for the improvement of the study in order to obtain more satisfactory results. Among the suggestions that can improve the study is the study of mapping is more comprehensive by involving all products produced by selected companies. In addition, in terms of the construction of the questionnaire, some structures can be improved to be more in line with what is to be studied in the industry itself. This is intended so that the factors studied are more specific and accurate.

In addition, the company as a respondent in conducting the study can be multiplied so that the study can be done more accurately and should be studied continuously in order to help the SME industry solve problems and also reduce the losses faced by them. This is in line with the ongoing knowledge building on supply chain development in the SME food manufacturing industry.

6. Conclusion

In conclusion, supply chain analysis in the industry is important so that the journey of a company runs smoothly in producing quality products and can meet customer demand. This analysis includes in terms of studies on supply chain mapping as well as risk analysis occurring in the food manufacturing industry. Next, measures to prevent need to be taken and must be emphasized so that the risk can be reduced and in turn can be avoided from happening bear times. In this study, the objectives that have been set have been achieved. For the first objective, supply chain network mapping was done based on the selected companies where the mapping focused on one key product from that company. Furthermore, for the second objective, the type of risk that occurs in the supply chain and also the causal factors for each risk can be identified using data obtained during the visit, interviews conducted and also through questionnaires that have been distributed to companies. which is studied.

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