

# ASSESSMENT OF SUPPLY CHAIN RISK MATRIX MESUREMENT. CASE STUDY: AGRI FOOD SMES ENTREPRENUERS IN SOUTHERN REGION MALAYSIA

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**Abstract:** *Supply chains have grown rapidly in recent decades, with the intention of boosting productivity, improving efficiency, and encounter the product in emerging markets. The increasing complexity of a supply chain reduces visibility and, as a necessary consequence, control over the process. To accomplish this, we must first identify potential risks and assess their consequences, while also developing risk mitigation policies to locate and relocate resources to deal with them. The purpose of this research is identifying a supply chain risk matrix for Agri food SMEs, which will be used to develop an appropriate supply chain risk mitigation strategy for entrepreneurs. The framework addresses supply-side risk, manufacturer-side risk, demand-side risk, logistic risk, information risk, and environmental risk towards supply chain performance. A comprehensive interview session was completed by 5 Agri Food Entrepreneurs based in the state of Johor. To assess most significant risks to supply chain performance were identified using variable qualitative measure risk variable f(frequency) versus qualitative measure I(impact)with an emphasis on the value of risk variable that affected Agri food entrepreneurs supply chain over the past three years. To supports the concept of SME supply chain risk, supply chain risk matrix mapping was performed. According to the results, the most impactful and high frequency supply chain risks are logistic risk and*

*demand side risks. For future study, there is a empirically verification of this identification of supply chain risk. The theoretical contribution of this study is support of theory Resource Based View (RBV) and dynamic capabilities theory as supportive theory.*

**Keywords:** *supply chain risk, supply chain performance, supply chain risk matrix, Agri Food entrepreneurs, SMEs*

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## Introduction

Supply chain management has been one of the key strategies adopted by companies to increase competitiveness in an increasingly competitive environment. To deal with a number of unforeseeable events that have a significant impact on the supply chain, corporations should develop plans to manage the risks that can have an impact on supply chain performance as a whole or individual firms within the sector (Agan, 2005). Thus, understanding the types and nature of risks that affect supply chains and their sources (Aigbogun et al., 2014) is critical for developing management strategies for mitigating risks while ensuring the chain's continuous operation (Al-Balushi et al., 2020). The distinctive characteristics of agrifood supply chains. The unique characteristics of agrifood supply chains (AFSCs) distinguish them from traditional supply chain networks, and they become more complex, which has a direct impact on their risk source. Furthermore, the AFSCs may differ in size, framework, structure, and specific product, and these characteristics may expose the AFSCs to varying levels of risk and vulnerability. An agrifood supply chain is defined as an integrated system that spans the entire manufacturing cycle, from agricultural production to product consumption, whether processed or not, and where the products may or may not be processed (Ali, 2020). The defining features of agrifood supply chains (AFSCs) that distinguish them from traditional supply chain networks make them even more vulnerable to risks. The AFSCs' internal market is also more complex than the markets of other supply chains. Because of the seasonality of raw material production and the inflexibility of these production systems, the supply of agro-industrial products is seasonal, with a supply-demand gap (5,20,22).

Small and medium-sized enterprises (SME) contribute for 99.2 percent (645,136 companies) of all businesses established in Malaysia (National SME Development Council, 2012; Department of Statistics Malaysia, 2011). SME were viewed as an important component of economic development in both developing and developed countries around the world (Ali et al., 2021). Furthermore, SMEs benefit the country by creating jobs, increasing income, and promoting economic growth (Alkahtani et al., 2021).

SMEs, on the other hand, have several flaws, including their small size, lack of capital, and reliance on government assistance. Furthermore, the National SME Development Council (2012) identified several barriers to high performance. According to (Amin et al., 2018), a SME is a company that is less structured, has a small management group, is poorly organised, and uses informal risk management. As a result, the purpose of this study is to argue the advantages of implementing SCRM in Malaysian SMEs.

In this study, supply chain risk matrix measurement supply chain performance indicators are the criteria used to assess the performance of products, services, and manufacturing processes in supply chain system. Furthermore, performance indicators are operationalized process characteristics that compare a system's efficiency and/or effectiveness to a norm or target value (Bak, 2018).

## Literature Review

### Specific risk in agrifood supply chain

There are several definitions of risks, as well as various theories for studying the subject in various contexts. With regard to agribusiness, (Barney, 2001) emphasise the importance of two important theories relevant to the study of risks: individual enterprise risks and supply chain risks. However, in this study, we are focused on the operational supply chain risks, not focused on the individual enterprise risks. In this perspective, we discover that the Agrifood supply chain can have various configurations, sizes, and structures, which have a direct impact on the sources and types of risk, as well as the chain's vulnerability level. According to the literature, an AFSC can be classified as follows:

- **The final product's purpose:** an agro industrial supply chain can be classified as either food or non-food. The main distinction between these chains is the issue of food safety. The safety of an AFSC's final product is the result of appropriate action by each of their productive agents. Thus, the supply of high-quality raw materials, the use of appropriate technologies and procedures at every stage of the supply chain, and workforce training and awareness are critical to ensuring consumer safety and well-being. Production and processing, transportation, storage, and packaging are examples of food chain vulnerabilities. (Batalha et al., 2015)
- **Level of product processing:** The AFSC can be divided into fresh food and processed product chains. In the case of fresh products, the primary activities are controlling, storage, packaged foods, logistics, and marketing, which allow the raw materials determine the actual to be preserved. In terms of manufactured product chains, agricultural products are used as raw materials for the manufacture of higher added-value products, and this process can increase the shelf-life of these products. (Beckman, 2007)
- **The perishability of the goods:** The products sold through the AFSCs can be classified as perishable or non-perishable. Perishable goods have a short shelf life, necessitating a complex logistics process and policy concerns about food security, whereas non-perishable items can be stored for extended periods of time. Although models of integrated planning, risk management, and chain coordination are important in all agro-industrial chains, they are especially important in perishable product chains. (Behzadi et al., 2018)

### Overview of Malaysian Agri Food Supply Chain

Malaysia's geographical location, agro-ecological zones, and available technical, financial, and logistics support services demonstrate the country's agri-food supply chain's potential to serve broader (national and global) markets in exchange for significant economic benefits. (Belhadi et al., 2021)

Malaysian's SMEs agri-food chain includes input suppliers, producers, wholesalers, processors, retailers, entrepreneurs, and distributors. Government play the importance roles for the performance SMEs Agri Food such as Ministry of Agriculture and Food Industries (MAFI), and National Farm Organizations (LPP) SMEs Agri food entrepreneurs under brand of PELADANG and Federal Agriculture Marketing Authority (FAMA). The chain's operations supported by financial, technical, logistical play the importance roles in Agri Food Supply chain consists of input suppliers, producers, wholesalers, processors, retailers and consumers. According to (Bhandari et al., 2020), several risk sources are probable in agri-food chain operations. In this study, we conducted interview session with Agri Food Entrepreneurs

### **Agri-food supply chain risk sources and performance measures**

Risk is a nebulous concept; thus, the definition of risk varies depending on the field of study (Bogataj, 2007). Risks (disruptions) in supply chain management can be defined as any event that halts any of the chain's three main flows, causing the distribution of potential outcomes to deviate (Caballero-Morales, 2021). As a result, in this study, agri-food supply chain risks (disruption) are defined as any potential variation in the chain's operations that has a negative economic impact on the chain's performance.

Previous research has identified the probability and impact of an event as the two most important components of supply chain risk (Can et al., 2020). Risks may arise from a variety of sources. (Cucchiella, 2006), respectively, envisioned three broad categories and nine subdivisions of risks. Supplier side risk, manufacturing side risk, logistic side risk, information risk and environmental risk. In this study we are focused on the operational/managerial risks influence the agri-food supply chain (Day, 1994). Performance metrics have been a critical management tool for facilitating the comprehension and integration of supply chain actors, as well as providing insights for better decisions that could bring the chain competitive advantages (de et al., 2017). Although determining what, how, and when to measure a firm's supply chain performance is difficult, previous studies have proposed agri-food chain performance measurement as total cost, customer responsiveness, flexibility, time, process, food quality, and safety (Dolgui, 2021).

### **Measurement of risk sources-related risk on agri-food supply chain performance.**

Previous studies have summarized the major enterprise risk factors that are inherent with a corporation of any kind. For example, Grey and Shi (de et al., 2017) have classified those enterprise risks into two categories: core business risk, which consist of value chain risk and operational risk, and non-core business risk, which comprises event risk and recurring risk. Regarding the supply-side risk in particular, several ways of categorization suggested in existing studies can also be found, four of which are briefly described here. Zsidisin and Ellram (Dolgui, 2021) rely on a case study to group the supply risk factors into incoming materials, source process capability, volume capacity, technologically capable, and supplier lead time. Specifically, we classify the supply risks into five families: capacity related, technology related, supply related, currency related, and disasters related, each of which consisting of a number of risk elements. These risk families not only consider the capacity limitation and technology gaps existing in potential suppliers, but also take into account the locations and external impacts of the suppliers chain performance (Giannakis, 2016) Unresolved issues with the supplier's production and operations management, according to Lee and (GrÄ¶tsch et al., 2013), may result in poor supply chain delivery performance. As a result, the second hypothesis is proposed as follows: supplier's production and operations management could lead to poor supply chain delivery performance. As a result, the second hypothesis is proposed as follows:

H1. The higher the supply side risk, the poorer the performance of the agri-food supply chain.

Manufacturing risk refers to factors and events that affect the ability of companies to produce goods and services, quality and timeliness of production activities and profitability (Wu et al., 2006). Several contributions have focused on the assessment and management of supply and manufacturing risks. For instance, Zsidisin et al. (2004) present a framework of supply risk assessment techniques, while Tomlin (2006) investigates strategies for managing supply risk through an analytical model. Tse and Tan (2011) propose a framework for assessing product quality risk in a multi-tier global supply chain, in which the quality risk could stem from supply,

manufacturing or logistics operations in any tier within supply chain network. Tang (2006) claims that the key concern of supply chain risk regarding product manufacturing is to decrease the inventory cost associated with a certain range of products.

H2. The higher the manufacturing side risk, the poorer the performance of the agri-food supply chain

Unanticipated/highly volatile customer demand, insufficient/distorted customer information, and changes in food safety requirements could all result in demand-related risks in the agri-food chain (Nyamah et al., 2014; Jaffee et al., 2010). These risk sources could result in an incompatibility between the firm's projection and the actual, risking supply chain performance by disrupting the physical distribution of products to end-customers (Christopher and Lee, 2004; Lee et al., 1997; McKinnon, 2006). Based on the preceding discussion, this paper considers demand-related risk/disruption to be an important factor that can negatively impact supply chain performance. As a result, our first hypothesis is as follows:

H3. The higher the demand-related risks, the lower the agri-food supply chain performance.

Logistics and infrastructure are critical components of the agri-food supply chain. In supply chains, effective logistics and infrastructure aid in delivering the right product, in the right quantity, in the right condition, to the right place, at the right time, and at the right cost. Brimer (1995), Tarantilis et al. (2004), and Aghazadeh (2004) Rising energy costs, labour shortages, port congestion and closures, and unreliable service are common examples of logistics/infrastructure risks (Hauser, 2003; LaLonde, 2004). Disruptions to any of the critical decision-making factors, such as access to reliable and affordable transportation, communications, and information technology, could undermine the agri-food chain's performance (Jaffee et al., 2010; Joshi et al., 2009; Aramyan et al., 2007).

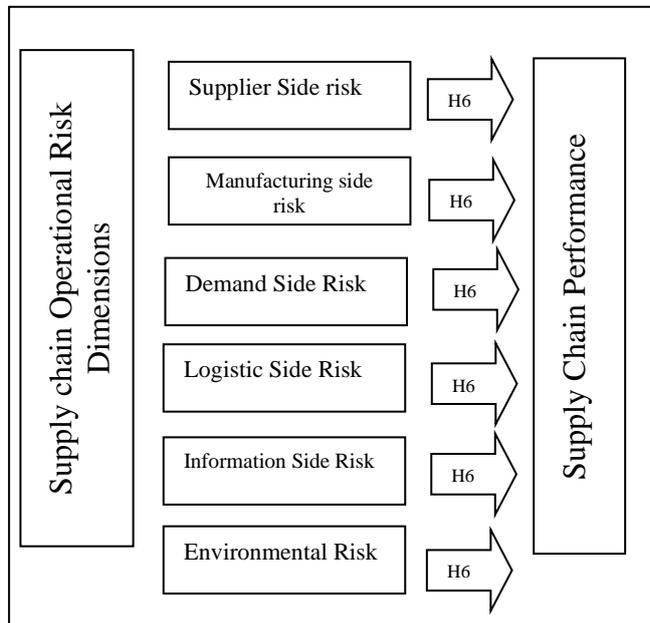
H4. The higher the logistic and infrastructure risks, the lower the agri-food supply chain performance.

IT is a major risk factor in increasingly intertwined supply chains. IT risks include, among other things, cyber and information security risks, exploitation of a supply chain partner's strategic information (Colicchia et al., 2018a), IT infrastructure breakdowns, a lack of effective system integration, and IT platform incompatibility (Yang et al., 2012). As a result, while IT is intended to improve supply chain performance and security, it also introduces new risks and interrelations.

H5. The higher the logistic and infrastructure risks, the lower the agri-food supply chain performance.

This risk includes natural disasters, socio political instabilities, and terrorist attacks. Wagner and Bode, 2008; Punniyamoorthy et al., 2013; Shenoj et al., 2016). Natural hazards such as floods and climate change are a constant threat in many parts of Malaysia, particularly to businesses. Because production facilities and transportation are highly vulnerable to natural disasters, the negative effects on the supply chain are obvious. According to a survey conducted by (Auzzir, Haigh, & Amaratunga, 2018), many SMEs reported being flooded at least once a year, with some reporting being flooded twice or more per year in the previous six years. However, the survey found an increase in unexpected natural disasters such as haze and heat.

H6. The higher the environmental risks, the lower the agri-food supply chain performance.



### Research Methodology

This study used a qualitative research design, with data collected through case study interviews with five SMEs managers from the agrifood industries. The managers are chosen at random from a list of SMEs available through the FAMA. It is due to the difficulties in obtaining permission from many managers to be interviewed. The goal of the interview is to learn the manager's perspective on business risk regarding supply chain issues faced by these firms, as well as the severity of these issues. To ascertain risk sources and supply chain issues, relevant questions were posed to interviewees using the supply chain diagnostic tool framework developed by Foggin et al. (2004). The questionnaire was designed in two stages, as is common in survey-based research. Following the advice of Li et al. (2005), this paper conducts a thorough review of the agri-food supply chain risk literature in order to identify the potential threats to SME's agri-food supply chain (Nyamah et al., 2014) Agri-food practitioners and researchers assessed the validity of identified risks by evaluating the identified risk items in a drafted questionnaire relating specifically, wording and directions, clarity, and format. Before drafting the final questionnaire, the research involved a face-to-face pre-test survey among some practitioners and researchers. The questionnaire's final version includes 2 sub-categories of nine major risk sources. Since the purpose of this study is to investigate the effects of various agri-food supply chain risks on performance rather than the influences of risk management activities conducted by the actors, risk management was included as a control variable.

### Analysis and Results

#### Background of Company.

The company was selected based on the list from the Agrifood entrepreneurs in Malaysia by FAMA and NAFAS in southern region. We conducted the interview session by question survey based research. We have done interview five entrepreneurs regarding supply chain risk management, below the background of the Agrifood entrepreneurs :

**Table 1: Company Profile**

Case study	Company Profile
A	Interview Position: Owner/Manager (Female) Category Food industry: snack food based on fish Company ownership: sole proprietorship Company Annual sales in past 3 years: RM100 000 -RM200 000 No of employees: 10 Sustaining in food industry: More than 20 years
B	Interview Position: Owner/Manager (Male) Category Food industry: snack food based on agriculture product (tapioca, banana, etc) Company ownership: partnership Company Annual sales in past 3 years: More than RM500 000 No of employees: 50 Sustaining in food industry: More than 20 years
C	Interview Position: Owner/Manager (Male) Category Food industry: Bottling fresh fruit with Rojak Dip Company ownership: partnership Company Annual sales in past 3 years: More than RM250 000 No of employees: 10 Sustaining in food industry: More than 7 years
D	Interview Position: Owner/Manager (Female) Category Food industry: food process based on fish Company ownership: Sole proprietorship Company Annual sales in past 3 years: More than RM200 000 No of employees: 3 Sustaining in food industry: More than 3 years
E	Interview Position: Owner/Manager (Female) Category Food industry: Bakery and frozen food based (Meat and chicken) Company ownership: Sole proprietorship Company Annual sales in past 3 years: Less than RM100 000 No of employees: 10 Sustaining in food industry: More than 3 years

There are five Agri food SMEs entrepreneurs involved in this study, most of them are owner and managers position (Table 1). Four of the interviewees are specific on agri food process based on agriculture sources (A, B, D and E), while the company C was produced fresh fruits as a main business. Based on the number of employees and sales turnovers per year, companies (A, B, C, D and E) fall into the small enterprise category because they have more than 5 but less than 30 employees and sales turnover less than RM300 000 (Guan et al., 2020).

### **Risk sources analysis**

We identified four agri food process in southern Malaysia that perform similar operations involving the manufacture of process food products. supplier side risk, manufacturing side risk, demand risk , information and environmental risk factors are shared by these industries. The interview were onducted based on the questionnaires and face to face session was conducted to

owners from these industries. A five-point scale was used to assess the significance of the risk sources. The respondents were asked to research the significance of each risk source under various risk constructs and rate the risk source on a scale of 1 to 5 based on the severity of the impact on performance. The five-point Likert scale is described as follows: 1 – very low risk, 2 – low risk, 3 – moderate, 4 – high risk, and 5 – very high risk over the three past years in the company situation. If a risk variable has a greater impact on the supply chain, it means that it has a negative impact on performance and creates more risk in the supply chain (Hartmann, 2021). As a result, the rating for such risk sources could be the highest (i.e. 5), the lowest (i.e. 1), or somewhere in between (i.e. 2–3) based on their severity impact. The instrument responses were used to test the instrument's validity as well as to prioritise the risk constructs. Table 2 explained and analysed the data gathered from the owners/ a managers in each company.

Risk Sources	Risk Evaluation in Company Past 3 years (Likert Scale = 1 (Very Low / 0 times), 2 (Low risk /1-3 times), 3 (Moderate / 4-6 times), 4 (High risk/7-9 times), 5 (Very High risk/ 10 or More times))		
	Risk Sources	Company	Indicator
Supplier Side Risk	Poor Quality	A = 3 B = 4 C = 4 D = 2 E = 2	Moderate High risk High risk Low risk Low risk
	Vague inspection procedure supplier	A = 3 B = 4 C = 4 D = 2 E = 2	Moderate High risk High risk Low risk Low risk
	Limited Numbers Of Suppliers	A = 1 B = 5 C = 4 D = 3 E = 3	Low Risk Very High Risk High Risk Moderate Moderate
	Frequent Changes Critical Material	A = 2 B = 2 C = 1 D = 3 E = 4	Low Risk Low risk Very low risk Moderate High risk
	Complexity of critical Material	A = 5 B = 2 C = 1 D = 4 E = 4	High risk Low Risk Low Risk High Risk High risk

**Figure 1: Supplier Side risk evaluation for Company A,B,C,D & E.**

Figure 1 is regarding about the supplier side risk. Based on the finding Company B and C and more very high risk and high risk for issues for supplier side poor quality, vague inspection procedure of supplier and limited number of suppliers, while company A, D and E have a complexity on critical material.

Risk Sources	Risk Evaluation In Company Past 3 years (Likert Scale = 1 (Very Low / 0 times), 2 (Low risk /1-3 times), 3 (Moderate / 4-6 times), 4 (High risk/7-9 times), 5 (Very High risk/ 10 or More times)		
	<i>Risk Sources</i>	<i>Company</i>	<i>Indicator</i>
Manufacturing Side Risk	Distruption Production	A = 2 B = 4 C = 4 D = 4 E = 3	Moderate High risk High risk Low risk Low risk
	High level of process variation	A = 5 B = 4 C = 3 D = 3 E = 3	Moderate High risk High risk Low risk Low risk
	Frequent Product recall process	A = 1 B = 4 C = 1 D = 1 E = 2	Low Risk Very High Risk High Risk Moderate Moderate
	Improper handling maintance product inventory	A = 2 B = 3 C = 3 D = 3 E = 2	Moderate High risk High risk Low risk Low risk
	Inflexibility Capacity	A = 3 B = 4 C = 2 D = 2 E = 3	High risk Low Risk Low Risk High Risk High risk

**Figure 2: Manufacturing Side risk evaluation for Company A,B,C,D & E.**

Figure 2 is concerning about the manufacturing side risk. Based on the findings, Company A faced very high risk for high level of process variation, while company B,C and D face the hight risk for disruption of production. For company E, mostly are low risk on frequent product recall process and improper and maintained of product inventor compare to company B. Regarding inflexibility capacity, most of the company face low and moderate risk while company B faced with high risk of inflexibility capacity (Hase, 2021).

Risk Sources	Risk Evaluation In Company Past 3 years (Likert Scale = 1 (Very Low / 0 times), 2 (Low risk / 1-3 times), 3 (Moderate / 4-6 times), 4 (High risk/7-9 times), 5 (Very High risk/ 10 or More times))		
	<i>Risk Sources</i>	<i>Company</i>	<i>Indicator</i>
DemandSide Risk	Unanticipated or very volatile cusotmer	A = 4 B = 4 C = 2 D = 2 E = 2	High Risk High risk Low risk Low risk Low risk
	Large focus error in demand	A = 1 B = 4 C = 2 D = 1 E = 2	Low Risk High risk Low risk Very Low risk Low risk
	Frequent Delay to customers	A = 1 B = 3 C = 3 D = 1 E = 3	Very Low Risk Moderate Moderate Very Low risk Moderate
	Change in customer preferences	A = 1 B = 4 C = 2 D = 1 E = 3	Very Low risk High risk Low risk Very Low risk Moderate
	Reputation risk	A = 1 B = 3 C = 5 D = 2 E = 2	Very Low risk Moderate Very High Risk Low Risk Low risk

**Figure 3: Demand Side risk evaluation for Company A,B,C,D & E.**

Figure 3 is regarding about the demand side risk. Based on the findings, company A and B face high risk for unanticipated or very volatile customer, while company C face high level risk for reputation risk. While company D and E face moderate, low and very low risk for demand side risk variable,

Risk Sources	Risk Evaluation In Company Past 3 years (Likert Scale = 1 (Very Low / 0 times), 2 (Low risk /1-3 times), 3 (Moderate / 4-6 times), 4 (High risk/7-9 times), 5 (Very High risk/ 10 or More times))		
	<i>Risk Sources</i>	<i>Company</i>	<i>Indicator</i>
Logistic Side Risk	Inadequate operation and financial strength of the carrier	A = 1 B = 2 C = 2 D = 2 E = 2	Very Low risk Low risk Low Risk Low risk Low risk
	Poor design of transportation on the network	A = 5 B = 3 C = 2 D = 1 E = 2	Very High Risk Moderate Low risk Very Low risk Low risk
	Wrong choice of mode transportation	A = 1 B = 3 C = 2 D = 2 E = 3	Very Low Risk Moderate Low Risk Low risk Moderate
	Damages due to accidents/improper stacking	A = 2 B = 2 C = 1 D = 3 E = 4	Low risk Low risk Very low risk Moderate High risk
	Delay in delivery time	A = 1 B = 3 C = 2 D = 2 E = 3	Very low risk Moderate Low Risk Low Risk Moderate

**Figure 4: Logistic Side risk evaluation for Company A,B,C,D & E.**

Figure 4 is considering about the logistic side risk. Based on the finding most of the Company B, C, D, E face with moderate, low and very low risk regarding about the logistic side risk. While company A face very high risk regarding poor design of transportation network and wrong choice of mode transportation.

Risk Sources	Risk Evaluation In Company Past 3 years (Likert Scale = 1 (Very Low / 0 times), 2 (Low risk /1-3 times), 3 (Moderate / 4-6 times), 4 (High risk/7-9 times), 5 (Very High risk/ 10 or More times))		
	<i>Risk Sources</i>	<i>Company</i>	<i>Indicator</i>
Information Risk	Unavailbilityinformation communication infrastructure	A = 1 B = 4 C = 1 D = 1 E = 3	Very Low Risk High risk Very Low Risk Very Low risk Moderate
	Breakdown internal and exteranl or internal IT	A = 1 B = 2 C = 1 D = 2 E = 2	Very Low Risk Low risk Very low risk Low risk Low risk
	Inadequate security of Information system	A = 1 B = 2 C = 4 D = 2 E = 2	Very Low Risk Low Risk High Risk Low Risk Low risk
	Wrong choice of communication or infromation system	A = 1 B = 3 C = 2 D = 2 E = 3	Very Low risk Moderate Low risk Low risk Moderate

**Figure 5: Information risk evaluation for Company A,B,C,D & E.**

Figure 5 is regarding about the information risk. Based on the finding only company B faced high risk with unavailbility information communication and company C faced with inadequate security of information systems. For breakdown internal and external in information technology, most of the company scores very low risk and low risk.

Risk Sources	Risk Evaluation In Company Past 3 years (Likert Scale = 1 (Very Low / 0 times), 2 (Low risk /1-3 times), 3 (Moderate / 4-6 times), 4 (High risk/7-9 times), 5 (Very High risk/ 10 or More times))		
	<i>Risk Sources</i>	<i>Company</i>	<i>Indicator</i>
Environmental Risk	Policy uncertainty	A = 5 B = 2 C = 1 D = 3 E = 3	Very High Risk Low risk Very Low Risk Moderate Moderate
	Uncertainty Due to government laws and regulations	A = 5 B = 3 C = 1 D = 3 E = 3	Very High Risk Moderate Low risk Moderate Moderate
	Experience severe currency of price fluctuations	A = 1 B = 3 C = 5 D = 5 E = 3	Very Low Risk Moderate Very High Risk Very High Risk Moderate
	Pandemic Diseases Affecting to employees Health	A = 1 B = 2 C = 1 D = 4 E = 1	Very Low risk Low Risk Very Low Risk High risk Very Low risk
	Product unpredictable demand shift	A = 5 B = 3 C = 1 D = 4 E = 2	Very High risk Moderate Very Low Risk High risk Very Low risk

**Figure 6: Environmental Side risk evaluation for Company A,B,C,D & E.**

Figure 6 is explained about the environmental risk. Based on the finding company A faced very high risk for policy uncertainty, uncertainty due to government due to government laws and regulations and product unpredictable demand shifts (Y., 2018). For Company C and Company D faced very high risk in experiences severe currency of price fluctuations. For company E the environmental not much affected the organization because most of the variable score moderate, low risk and very low risk for the company.

Risk probability indicator and frequency. Risk matrices, which are tables that map "frequency" and "severity" ratings to corresponding risk priority levels, are widely used in applications ranging from terrorism risk analysis to highway construction project management, office building risk analysis, climate change risk management, and enterprise risk management (ERM). Many organisations and risk consultants have adopted risk matrices as a result of national and international standards (for example, Military Standard 882C and AS/NZS 4360:1999). In this study, we implemented risk matrix to analyze the severity and frequency of the risk sources in the organizations. For the severity rules of thumb 1 (Very Low Risk / <10%), 2 (Low Risk/ 11%-30%), 3 (Moderate Risk/31% -50%), 4 (High risk 51%-71%), 5 (Very High Risk 71% -90%). While the frequency are based on the mean of the likers scale analyses of the responded answers. Table 3 showed the risk sources analyses of the probability of severity and frequency of the supply chain risk (Khan, 2007).

**Table 3: Risk sources analysis**

Risk Sources	Risk Evaluation in Company Past 3 years Indicator Probability severity = 1 (Very Low Risk / <10%), 2 (Low Risk/ 11%-30%), 3 (Moderate Risk/31% -50%), 4 (High risk 51%-71%), 5 (Very High Risk 71% -90%)		
	Risk Sources	Company Percentage	Frequency
SSRA	Supply Side Risk Company A	56% = 4	3
SSRB	Supply Side Risk Company B	68% = 4	3
SSRC	Supply Side Risk Company C	56% = 4	3
SSRD	Supply Side Risk Company D	56% = 4	3
SSRE	Supply Side Risk Company E	60% =4	3
MRA	Manufacturing Side Risk Company A	52% = 4	3
MRB	Manufacturing Side Risk Company B	76% = 5	4
MRC	Manufacturing Side Risk Company C	52% = 4	3
MRD	Manufacturing Side Risk Company D	52% =4	3
MRE	Manufacturing Side Risk Company E	52% = 4	3
DSRA	Demand Side Risk Company A	32 % = 3	2
DSRB	Demand Side Risk Company B	72% = 5	4
DSRC	Demand Side Risk Company C	56% = 4	3
DSRD	Demand Side Risk Company D	28% = 2	1
DSRE	Demand Side Risk Company E	48% = 3	2
LRA	Logistic Side Risk Company A	52% = 4	3
LRB	Logistic Side Risk Company B	48% = 3	2
LRC	Logistic Side Risk Company C	40% = 3	2
LRD	Logistic Side Risk Company D	24% = 2	1
LRE	Logistic Side Risk Company E	44% = 3	2
IRA	Information Risk Company A	20% = 2	1
IRB	Information Risk Company B	55% = 3	3
IRC	Information Risk Company C	40% =3	2
IRD	Information Risk Company D	35% = 3	2
IRE	Information Risk Company E	50% = 3	3
ERA	Environmental Risk Company A	68% = 4	3
ERB	Environmental Risk Company B	52% = 4	3
ERC	Environmental Risk Company C	36% = 3	2
ERD	Environmental Risk Company D	76% = 5	4
ERE	Environmental Risk Company E	44% = 3	2

The probability that two risks can be unambiguously ranked (i.e., with zero error probability) using the risk matrix with  $x = y = 0.5$  is  $(1/2)(1/4) = 0.125$  (i.e., one of them falls in one cell of the "high/low" diagonal and the other falls in the other cell of that diagonal). The probability that the two risks cannot be compared using the matrix with better than random accuracy (50 percent error probability) is  $0.375 = (1/4)[(1/2) + (1/4) + (1/2) + (1/2) + (1/4)]$  (considering the four cells clockwise, starting with the upper left). The likelihood that the two risks can be compared using a matrix with an error probability greater than zero but less than 50%. Assume the risk matrix is built with  $x = y = 0.5$ , but it is used in decision situations where the joint probability distribution of Probability and Consequence is uncertain.

Risk = probability  $\times$  consequence (or frequency  $\times$  severity or likelihood  $\times$  impact or threat  $\times$  (vulnerability  $\times$  consequence), etc.

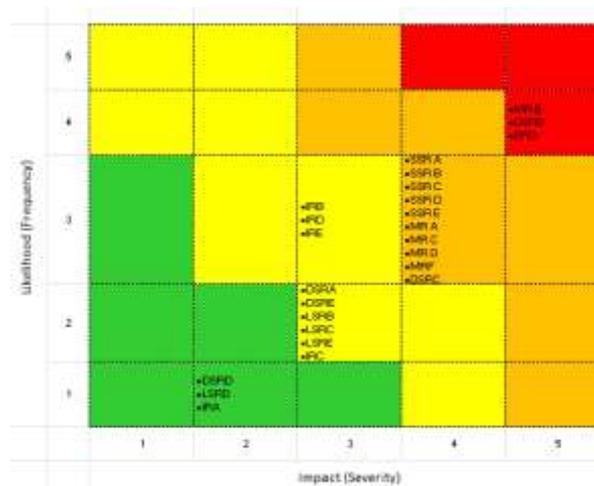
Now, the matrix's ability to determine which of two risks is greater is entirely dependent on the joint probability distribution of (Probability, Consequence) pairs. For example, if the Probability and Consequence values are distributed uniformly along the diagonal from (0, 0) to (1, 1), there is a 50% chance that the two risks can be classified with zero error probability (if one is in the high cell and the other is in the low cell); otherwise, the error probability is 50% (if both are in the same cell).

Based on Table III, risk sources analysis. A risk matrix, in general, divides alternatives (typically representing various threats, hazards, risk reduction or investment opportunities, risk management actions, and so on) into distinct categories that correspond to the different priority levels or "colours" of the matrix cells based on the indicator Figure 7 and the result was showed at Figure 8.

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	MEDIUM - Specific responsibility and treatment	MEDIUM - Specific responsibility and treatment	HIGH - Quarterly senior management review	EXTREME - Monthly senior management review	EXTREME - Monthly senior management review
Likely	MEDIUM - Specific responsibility and treatment	MEDIUM - Specific responsibility and treatment	HIGH - Quarterly senior management review	HIGH - Quarterly senior management review	EXTREME - Monthly senior management review
Possible	LOW - Accept the risk; Routine management	MEDIUM - Specific responsibility and treatment	MEDIUM - Specific responsibility and treatment	HIGH - Quarterly senior management review	HIGH - Quarterly senior management review
Unlikely	LOW - Accept the risk; Routine management	LOW - Accept the risk; Routine management	MEDIUM - Specific responsibility and treatment	MEDIUM - Specific responsibility and treatment	HIGH - Quarterly senior management review
Rare	LOW - Accept the risk; Routine management	LOW - Accept the risk; Routine management	LOW - Accept the risk; Routine management	MEDIUM - Specific responsibility and treatment	HIGH - Quarterly senior management review

**Figure 7: Risk matrix indicator.**

Risk matrices have received widespread acclaim and adoption as simple, effective approaches to risk management. They provide a clear framework for systematic review of individual risks and risk portfolios; convenient documentation for the rationale of risk ranking and priority setting; and relatively simple-looking inputs and outputs, often with appealingly coloured grids.



**Figure 8: Supply Chain risk matrix evaluation for Company A,B,C,D & E.**

Figure 8 shown the supply chain risk evaluation matrix for Company A, B,C, D and E. Based on the colour evaluation, “Red Zone Grid” knowing as a High level risk or severe consequences which is will extremely impact of supply chain and performance of the organization. In this situation top management should develop monthly review mitigation strategy to prevent the risk. For the Moderate to severe impact in the “Orange Zone Grid”. The companie still should have highly concerns in mitigation strategy quarterly review (Norrman, 2004).

## Discussion and conclusions

### Discussion.

According to the findings of the interview, the owners or managers of SMEs face a variety of supply chain risk issues. Table 4 shown the summary of finding for the company. The most common issue identified in supply chain sources are supplier side risk and manufacturing side risk for Agri food entrepreneurs (Nugraha et al., 2019). Based on the interview session, Company B profile mostly based on the agriculture sources product prosses, and the main sources was from the fresh agriculture product (J., 1892). Most of the issues face by the company B is regarding the disruption production, high level of the production, inflexibility in capacity and frequently recall process. Even the company sustaining 20 years in the market, Company B still faced supplier side risk especially in poor quality and values inspection of suppliers. The another’s company who faced with the severe and extreme consequences are Company D. Based on the interviewed session with the owners of the companies, the main sources of the product are based on the fresh fruits, like mango, pineapple, guava, and jackfruit. In this situation, company D face with the environmental risk like product unpredictable demand shifts, experience with severe currency of price fluctuation especially relate imported fresh fruits and due to pandemic situations, its really effect the organizations (K., n.d).

Regarding logistic side risk and information risk, its not really highly impact consequences for Agri food entrepreneurs company.

**Table 4: Summary findings**

Case study	Major Supply Chain Risk sources issues	Severity
A	Supplier side Risk Manufacturing Side Risk	Moderate to Severe
B	Manufacturing Side Risk Demand Side Risk	Severe
	Supplier side risk	Moderate to Severe
C	Supplier Side Risk	Moderate to severe
	Demand Side Risk	
	Manufacturing Side Risk	
D	Environmental Risk	Severe
	Supplier Side Risk Manufacturing Side Risk	Moderate to severe
E	Supplier Side Risk	Moderate to severe

### Conclusion

Companies are increasingly looking for ways to develop effective relationships with other firms in their supply chains to gain a competitive advantage. However, with this type of risk sources, companies become more vulnerable to the risks associated with SC. In this context, knowing the risks that affect the various supply chains is critical to effective risk management. As a result, the Agrifood supply chains differ from other chains in some ways, and these differences have a direct impact on their dynamic operation; as a result, the agri-food supply chains become more complex and vulnerable to risks that do not exist in other chains (R., n.d). This paper classifies Agri Food Supply chain risk sources based on their main characteristics and proposes a model for classifying the risks inherent in these chains based on a systematic review of the literature. Risks were classified into four categories in this context: I risks within the firm; (i) risks in supplier side risk to (ii) manufacturing side risk (iii) demand side risk (iv) risks external environmental risk is to conduct a literature review in order to identify the major risks associated with agri-food supply chains and their characteristics (Y. et al., 1987).

Finally, the findings of this study indicate that the proposed model allows us to better understand the risks that can impact agri-food supply chains and can be regarded as the first stage in effective supply chain risk management (M., 1989). As a result, the model proposed in this paper was explicitly formulated in order for future empirical research to be more favourably reviewed. This is supported by (39) to supported with sources more significant.

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