

# Identifying the Risk Dynamics of Supply Chain Operations in Large Scale Apparel Industry in Sri Lanka

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**Abstract**—Risk assessment is an important process in the supply chain risk management system to identify the risk profile of an organization. This study is focused on identifying the risk assessment of Large-scale apparel manufacturing firms in Sri Lanka. The research investigates the risk assessment in the perspective of the supply chain management personnel as the focus group for this study. Risk matrix approach is used in the analysis process and critical supply chain risks are identified for development of risk response strategies. Twenty eight potential causes for exposing to the supply chain risk are assessed in this study. These risk factors are categorized under nature related risks, political system created risks, competitor & market generated risks, internal operations related risks, available capacity caused risks and information systems related risks.

**Index Terms**—Apparel, risk assessment, risk matrix, supply chain.

## I. INTRODUCTION

Modern business environment demonstrates a complex and dynamic nature where businesses are subject high degree of uncertainty. Despite of this uncertain nature in the business environment, businesses try to achieve their primary objective in business which is to generate and increase profit. Main focus in achieving this objective is through optimizing the supply chain by increasing the productivity and reducing the costs in all the processors. Intensive competition in the modern business environment also has increased the pressure on organizations to optimize their supply chain to survive in the market.

There are over 300 Apparel manufacturers in Sri Lanka which are categorized in to Large-scale manufactures and Small & Medium scale manufactures based on their average annual revenue. Though there are over 300 Apparel manufactures in Sri Lanka, more than 90% of the business is carried out by 15 large scale manufactures. This research study is focused on these key players in the apparel industry in Sri Lanka to understand the underlying factors of the risks experienced by the Apparel industry supply chains in Sri Lanka and the actions taken by the businesses to mitigate the risks.

Purpose of the research is to study how the supply chain risk/uncertainty factors are identified and assessed by the large-scale apparel manufacturing industry in Sri Lanka.

Study is structured in main there areas 1) Understand the key drivers of supply chain risks in Sri Lankan Apparel industry, 2) Evaluate the likelihood and impact of the risk

factors in the industry and 3) Investigate instruments for dealing with identified critical supply chain risks based on various supply chain risk management strategies examined in research literature.

Apparel industry in Sri Lanka is a primary foreign exchange earner and account for 43% of the exports from Sri Lanka and 52% of the total industrial exports. Apparel industry consists of major human resource component supplying more than 300,000 direct employments and 600,000 indirect employments approximately. Export trade, complex procurement, various product quality requirement, seasonality of demand, intense global competition and many other factors have increased the risk associated within the supply chain. Therefore, risk management processors are vital for the survival of the industry.

## II. LITERATURE REVIEW

### A. Risk

Concept of 'Risk' and theoretical study of risk originated in 17<sup>th</sup> century by two French mathematicians, Blaise Pascal and Pierre de Fermat. This study was the basis for the development of the Probability Theory. The concept of Risk is based on this theory as the probability/uncertainty is the cause of risk. Therefore probability theory is considered as the heart of the concept of risk [1]. However, with the major technological advancements, the expansion of the size and globalisation of organisations in 1950s and 1960s risk and its management became a concern to the business community [2].

Many definitions have been developed for the Risk over the time. Various literatures describe risk in different formats in different perspectives. As examples reference [3] defines risk as the uncertainty of loss, reference [4] defines risk as the alteration of future results under a given circumstance in a specific period, reference [5] defines risk as the possibility of unfavorable results and the related loss of a chosen decision plan due to various uncertainties in the decision making process. ISO Guide 73:2002 definition of risk as the 'effect of uncertainty on objectives'

Reference [6] identified five characteristics of risk; (1)Objective existence (2)Abrupt (3)Harmful (4)Uncertain & (5)Developing. In this research, authors described these characteristics in defining the risk. The objective existence of the risk as risk can never be eliminated even with a lot of effort. Risk can only be mitigated, controlled, transferred or evaded but risk never can be eliminated. Risk is described as abrupt because of the limited awareness of the people. People are affected by risk suddenly due to lack of perception.

Harmful characteristic of the risk is explained as people will suffer a loss due to presence of risk. This can be small or huge, fatal or minor but there is always some loss to people. Uncertainty of risk is explained as unexpected nature of the risk.

Risk can be identified as combination of probability of occurrence of the unexpected event and the impact of that unexpected event. Probability of occurrence is the likelihood of the unexpected event taking place. Impact is the magnitude of the results caused by the unexpected event or hazard. Reference [7] and [8] describes risk as a measure of the probability and severity of adverse effects caused by a hazardous event or unexpected activity. Reference [9] defines risk as the potential for unwanted negative consequences to arise from an event or activity. Here the potentiality is expressed as the probability of occurring of the negative consequences and the impact is considered in the negative results. In reference [10], authors identify risk in the perspective of project management and the project objectives. In this research, it perceives risk in terms of the likelihood of an uncertain event or set of circumstances occurring which would have an adverse effect on the achievement of a project's objectives. Reference [11] defined risk in the perspective of an individual.

### *B. Risk Management*

Reference [12] defines risk management as "The identification, analysis and control of those risks which can threaten the assets or earning capacity of an enterprise". Similarly reference [13] described risk management as a general management function that seeks to assess and address risks faced by the business in achieving the objectives of the business. In another study main aim of the risk management is described as a supportive organizational activity to help all other management activities to achieve the organization's aims directly and efficiently [14].

Most literatures suggest that the risk management should be incorporated into the culture of the organization [15]. As an example reference [16] suggests that risk management as a continual process that requires long term dedication of the supply chain members. Reference [17] states, risk management as a 'formal process that involves identifying potential losses, understanding the likelihood of potential losses, and assigning significance to these losses'. Some researches stand on the view point of that effective risk management does not need a highly formalized and structured process; rather it should be based on commonsense [10] and [18].

Most approaches in risk management studies describe three processes in developing a risk management system. 1) Risk Identification; 2) risk analysis/risk estimation and 3) risk evaluation. As an example, reference [9] and [19] defines the risk management process as the making and implementing of decisions concerning risks based on risk estimation and risk evaluation. Reference [10] divided risk management approaches into three groups; 1) Qualitative techniques; 2) Quantitative techniques, and 3) Control techniques. Reference [20] and [21] show a similar view and categories these techniques into four categories; formal, informal, qualitative and quantitative.

### *C. Supply Chain Risk Management (SCRM)*

Different researchers have identified different reasons and causes for supply chain vulnerability. The difference of SCRM to traditional risk management is that, SCRM focus on entire supply chain rather than focusing on the individual company level in identification of risks and developing risk mitigating strategies in cross company orientation [22].

There are many literature published on sources of Supply Chain Risk (SCR). Most of the literature describes mainly three areas of uncertainty in supply chain; 1) uncertainty about quantity, 2) Uncertainty about quality and 3) Uncertainty about time. Trend towards outsourcing has also increased the SCR due to additional dependencies on third parties and increased complexity in network of the Supply Chain (SC) [23]. Another factor to increase the risk in supply chain is globalization [24]. Complexity of business network also has caused an increase in risk in supply chain. More complex networks demonstrate more vulnerability as there are more interfaces exist in the SC [25] and [26]. Reference [27] describe the effect of external events on SC and business and how they increase the vulnerability of SCs. Reference [28] identified nine modern business trends which increase the vulnerability and risk to the SC.

Researchers have studied different aspect and different causes for risks present in the various businesses. In reference [29], author has studied lean manufacturing and global sourcing and supply chain risk management. Reference [24] and [30] has conducted a study in several industries analyzing global sourcing and supply chain disruptions empirically. Reference [31] has evaluated different kinds of supply chain disruptions based on an empirical study. In the reference [32] and [2], authors have investigated the effects of supply chain disruptions on stock prices and equity risks.

Various studies have categorized SC risks into various categories for analysis and simplification purposes. Reference [33] has divided the supply chain risks into two main types; 1) Technological risk and 2) Strategic risk. In the reference [34] authors have divided supply chain risks into two categories, 1) internal and 2) External. In a study conducted in 2005 categories supply chain risks into two categories: 1) risks arising from coordinating complex systems of supply and demand, 2) disruptions [35].

### *D. Risk Quantification and Assessment*

Risk assessment is a main process in the risk management system. This is used to quantify the risks that businesses are subject to. This quantification is useful in evaluating the risks. The most commonly used quantification method is define risk using probability of occurrence and impact of the consequence. Using these variables reference [11] introduced a standard formula for a quantitative definition of supply chain risk,

$$\text{Risk} = P(\text{Loss}) * I(\text{Loss})$$

Reference [36] also stated that risk management normally begins by assessing the two factors of risk, likelihood of a specific event occurring and the consequences if the event actually occur.

There are mainly three ways to perform a risk assessment [6] and [37];

- 1) Qualitative way
- 2) Quantitative way
- 3) Semi quantitative way

Semi quantitative method uses the positive points of both the other methods this method is widely used in risk assessments.

**E. Risk Matrix**

Risk matrix approach was initially developed by US Air force Electronic Systems Center in 1995 to access the risk in life cycle of purchase products [25]. Risk matrix approach is a semi quantitative method and is the most commonly used risk assessment method in risk management studies. Reference [38] and [20] applied Risk Matrix Approach (RMA) to a technical project’s risk management. In another study researchers designed the risk matrix to assess the risks related to a loaning programme of commercial banks in China [7]. Reference [39] applied RMA to a real estate project decision making system in assessing the risk in business. In reference [38] authors have developed the risk matrix approach to identify and assess the risks related to operation of metro system.

Risk matrix is developed using two variables of risk, the severity of undesirable event’s consequence and the likelihood of occurrence of the undesirable event. In the original risk matrix severity (the impact of each identified risk factor on the project if that risk related incident occurred) is divided in to five levels with a scale of 0 to 5 and probability of occurrence of the identified risks is divided into five levels with probability from 0 to 1. The Risk index in original risk matrix is divided into three levels (Table I). In this matrix the risk indexes are shown in a graphical format where H, M, L denotes High, Moderate, Low risk indexes (Fig. 1).

		Probability				
		0.00-0.10	0.10-0.40	0.40-0.60	0.60-0.90	0.90-1.00
Impact	Negligible	L	L	L	M	M
	Minor	L	L	M	M	H
	Moderate	L	M	M	M	H
	Serious	M	M	M	H	H
	Critical	M	H	H	H	H

Fig. 1. Standard risk matrix.

TABLE I: SCALE FOR RISK MATRIX

Severity	Scale	Probability	Probability scale
Negligible	0-1	Remote	0.00-0.10
Minor	1-2	Unlikely	0.10-0.40
Moderate	2-3	Likely	0.40-0.60
Serious	3-4	Highly likely	0.60-0.90
Critical	4-5	Near certainty	0.90-1.00

Reference [6] further describes the negative aspects of the risk matrix, where risk matrix is applied to a specific case the different risks can share the same risk index due to limited options. To Address this scenario variations from original risk matrix were designed. In reference [37] authors have introduced rezoning of matrix as a method of reducing the

negative aspects of the original risk matrix. In this approach severity and probability are divided into more levels than the standard risk matrix (Fig. 1) to design more options and risk indexes. Reference [20] introduced “Borda method” to risk matrix to reduce the negatives of the original risk matrix.

**III. RESEARCH DESIGN**

Research consists of two parts, one is to identify the risks and challenges faced by the apparel industry due to modern developments in the business environments and the second is to identify organization specific risks.8 developments in the modern business world are identified for assessment,

- 1) Globalization of supply chain
- 2) Outsourcing to third parties
- 3) Reduction of suppliers
- 4) Complexity in customer demand
- 5) Increased concern for ethics
- 6) Green concepts
- 7) Global competition
- 8) Technological advancements

Second section of the Research is mainly divide risk factors into two categories, 1) External risk factors; 2) Internal risk factors. These risk factors are then sub divided into 3 sub categories for better understanding of the risk areas. External risk factors are divided into Nature related risks, Political System created risks and Competitor & Market generated risks. Internal risk factors are divided into internal operations related risk factors, Available capacity caused risk factors and Information Systems related risk factors.3 to 6 specific risk factors are identified under each of these subcategories for easy analyzing purposes total of 28 risk factors.

This study focused on identifying the supply chain risk assessment of large scale apparel manufacturers in Sri Lanka. Therefore the study is limited to supply chain risk management of the 15 large scale apparel manufacturing companies.

Online questionnaire was used to gather data which recognized the responses via a five point Likert scale.

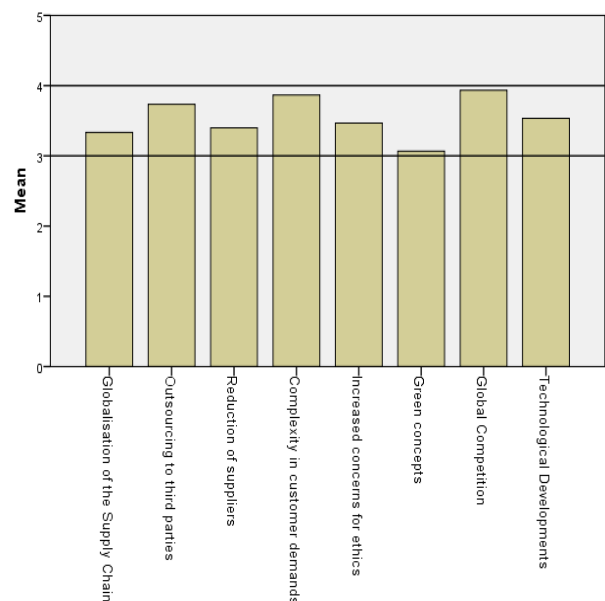


Fig. 2. Industry wide risk factors.

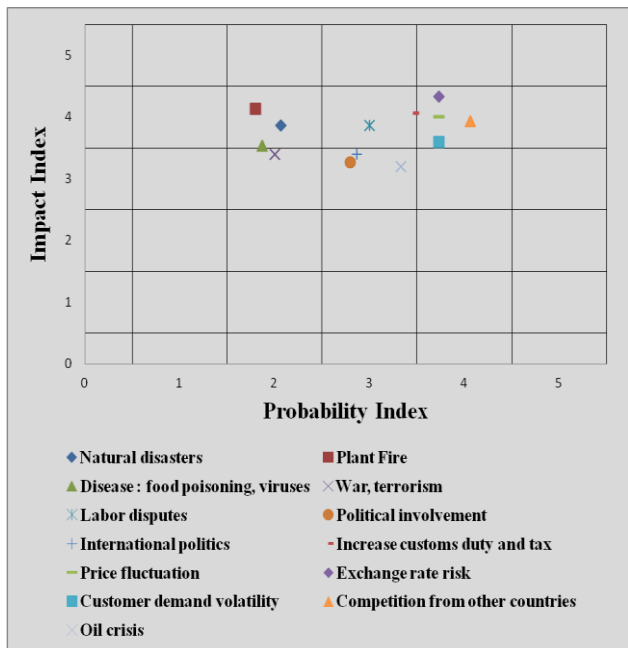


Fig. 3. External risk factors –risk matrix.

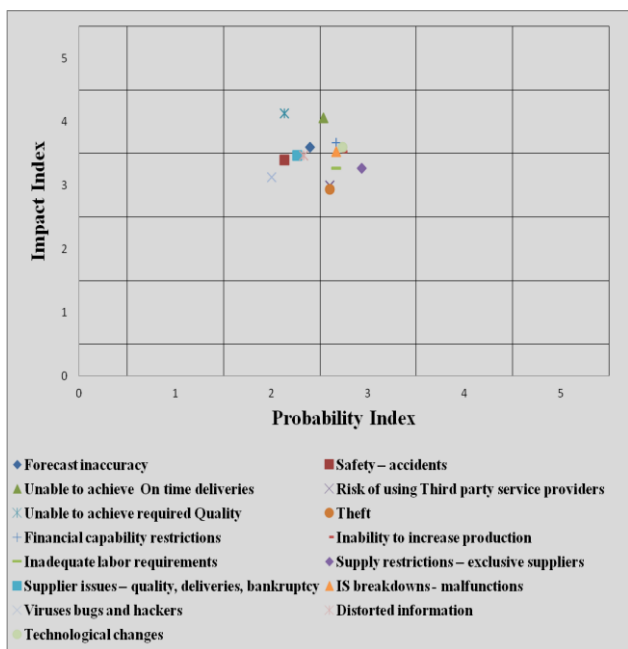


Fig. 4. Internal risk factors –risk matrix.

IV. RESEARCH FINDINGS

Research data scale obtained a cornbach’s alpha score of 0.939 which indicate that the scale used in measuring the data is highly reliable.

The large scale apparel manufacturing industry in Sri Lanka considers assessed eight risk factors create impact of moderate to high scale. Global competition is the number one risk factor present for the supply chains of large-scale apparel manufacturing industry in Sri Lanka.

Complexity in customer demand and outsourcing to third parties hold the second and third position in the industry wide risk factor rating in the focus group (Fig. 2).

Fig. 3 demonstrates the risk matrix for all external risk factors considered in this research. There are five risk factors in the critical zone of the matrix. Those factors generate critical level of risk exposure on the large scale apparel

manufacturers in Sri Lanka and their supply chains. These risk factors are,

- 1) Exchange rate risk
- 2) Price fluctuation
- 3) Customer demand volatility
- 4) Competition from other countries
- 5) Increase in customs duty and tax

Fig. 4 demonstrates the risk matrix for all internal risk factors considered in this research. There are no critical internal risk factors affecting Large-scale apparel manufacturers in Sri Lanka. There for if any organization assesses these risk factors more than the industry average they should re-evaluate and re-assess the risk factors to identify the true risk exposure and develop strategies to control their risk exposure. Companies should regularly monitor to identify and verify any increase in the risk exposure.

V. CONCLUSIONS AND RECOMMENDATIONS

Large-scale apparel manufacturing firms in Sri Lanka are subject to number of risk factors present in the business environment in different magnitudes and different levels. Assessment of the level of exposure to risk is a subjective measurement by the management of the organization. Management in different organizations may assess the same risk in considering different relevant to their operations. Different strategies can be adopted to mitigate critical risk exposure of the organization.

With respect to the development of exchange rate risk management strategy; organization should identify hedging method to manage identified currency risks manage exchange. Operational hedging can be as a mean of reducing and sharing risk of price fluctuation. Improving information system is a mean of reducing the risk generated by the customer demand volatility. Licensing can be used as a method of securing the demand for the future.

With respect to major risk factor faced by the apparel industry in Sri Lanka; mainly China, Bangladesh, Vietnam and India create a huge competition for Sri Lanka. All these countries enjoy the low cost labour in their manufacturing. Sri Lanka must develop strong strategies to win the competition. Government support through developing good, foreign relationship with apparel markets, Strategic alliance of large scale local manufactures to win the world market, emphasis on ethical manufacturing as other competing countries are accused of using child labor can be suggested as recommendations for mitigating risk from competition from other countries. Company can get benefit from government local tax policies by operating in rural areas and free trade zones. Also government gives tax concessions for location factories on under developed areas or post war zones.

VI. LIMITATIONS OF THE STUDY

There can be three limitations identified in this research. First and major limitation was the reluctance of the company managers to provide information. This was mainly due to the busy working environment and company policies preventing disclose of data to research studies without a prior approval.



Obtaining approval process is very lengthy in many companies. Second limitation was that most of the selected companies not having a specific supply chain department. Though the focus group was large scale apparel manufacturers in Sri Lanka, there were no position or department for supply chain management in many organizations. Third limitation was most of the intranets filter the web based questionnaires. This increased the response time of the respondents.

## VII. SUGGESTIONS FOR FURTHER RESEARCH

This study only focused the Large Scale Apparel manufacturers in Sri Lanka which only accounts for 5% of the total apparel manufacturing companies. Therefore the research can be continued to identify the assessment of these risk factors by the small and medium scale apparel manufacturers. Risk is present in any business, therefore this study can be expanded to identify the risk factors faced by other manufacturing and service organizations and analyze their assessment of those risk factors. This study used risk matrix in assessing the risk factors and their level of exposure to the industry. There are other risk assessment methods and developments in risk management study area.

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