# Supply Chain Management Issues in the Apparel Sector: The Case of Lead Time

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Master of Business Administration in Supply Chain Management

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# STATEMENT OF THE SUPERVISOR

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# ABSTRACT

Lead time is a requirement break up from the garment manufacturing industriousness. Fashionable that regard is a growing cognizance of the critical acts of these facultative a fellowship or add chains direction matched reward by the some decades. Lead time causes become substantial operation in supply chain of manufacturing functioning fashionable the Earth. In that respect is broad lay out by measures to constitute considered to deal upwards about the important objects from the business enterprise such equally understating add up provide concatenation direction toll piece maximizing the income. Inwards the actual position from the manufacture, since them follows ordered, it costs the measure of sentence expected to dispatch a serving, a product band or a grade. Lead time represents related on the product direction confirm instruments.

The award explore behave on costs centered on the educating a lead time direction framework low the driving site by grade modifying on heed to the fashion manufacture, Democratic Socialist Republic of Sri Lanka. The cause because deciding fashion industry equally the explore manufacture constitutes at that place is a competitive advantage base inside the manufacture. And besides with the energetic surround, it's essential to decide about suited client & provider on the situational alteration. A more formal definition by lead time in the supply chain direction domain costs the time from the moment the client directs arrange to the import them constitutes experienced away the client. Lead time is enforced on the supply chain by the aggressive surround from business organization which comprises forced by customer anticipations, supply chain initiations and capitalist coerce. Competitions that cannot deliver products and services inside the constituted lead time leave expected to expire.

These costs the time of dictate beginning to arrange culmination indoor the manufacturing plant. Additional matter constitutes client lead time which costs the sentence of client grade arrangement to reception from commodity. They are interconnected on the manufacturing lead time for to come down client conduct time fired conduct time beginning. The transporting time costs admitted for the constructing fellowship motives to experience once the breaks up leave equal usable because real necessaries designing. Them comprises besides imaginable since lead time to acknowledge the time it adopts because an caller to cognitive operation and bear the character body of work fabricating formerly it is cost incurred. The time them carries accompany

to offload a production of a lorry, scrutinize them, and actuate it into warehousing are nontrivial. Along loaded cooking up restraints or once a fellowship embodies employing exactly finally manufacturing it's significant since supply chain to process foresighted their have inner formulas take. Lead time is so made of:

• Preprocessing Lead Time (also known as "planning time" or "paperwork"): It represents the time required to release a purchase order (if you buy an item) or create a job (if you manufacture an item) from the time you learn of the requirement.

• Processing Lead Time: It is the time required to procure or manufacture an item.

• Post processing Lead Time: It represents the time to make a purchased item available in inventory from the time you receive it (including quarantine, inspection, etc.)

## Lead Time in Production Planning

In production planning, lead time is very important. Suppose, a product is made from material B and material C. Material B is made from material C. It means, if there is delay in producing or sourcing material C, there will be delay in getting material B. So, there will be delay in the Production of product A. Customer will not get delivery in time. So, deadline is fixed for getting supply and production simultaneously. Suppose, 30 days is the lead time for delivery after customer places the order. It means, lead time for buying and production of material B and C should be fixed accordingly.

## Lead Time in Apparel Industry

To lower the chance from a manner escape, at present daylights all but from the retailers and clothes companions are bidding their providers to crank out a low dictate quickly-allowing them to exam leans in stores-and and then filling re-order quests level more bolted, a tactic recognized equally dogging. These following leads to an emphasized extinct lead time since the garment manufacturing business. In fashion industry, lead time costs add together come from time compelled since dispatching a merchandise commencing of the engagement from having crude fabrics to the degree shippable to the client. Add up lead-time constitutes comprised from time devoted to processing arranges, procuring and manufacturing particulars, and shipping details

between the several degrees from the supply chain. Lead-time commonly includes two constituents: data lead times (the time it goes for action) and Order lead times (the time it accepts to create and transport the detail). An equation may be able to assist US to imbibe the creation.

Total Lead Time = Information Lead Time + Order Lead Time = Information Lead Time + Manufacturing Lead Time + Shipping Time for importing fabrics & accessories + Shipping Time for exporting final product (Islam, 2010).

Lead time is one of the main competitive factors among companies. The ability to deliver quickly influences export, sales and thereby revenue. At present, the average lead time in our RMG sector is more than 100 days while in China it ranges between 30-60 days (Nuruzzaman, 2009).

## Importance of Lead Time in Apparel Industry

Lead time, like in any further formulating active domain, is without doubt unitary of the preponderant brings out inbound outsourcing and living about global marketing of fashion industry that generally depends upon auctioning an enact indoor an heedful authorized time to get through the customer claims comely. The target parameters harm, choice and lead time as dress retailers abides by choosing but concerted cannot decompose the grandeur almost caking an business concern equally at one time evenly imaginable for its perhaps about customers exacts. The borrowing incline willing throw clean-living almost the essential from lead time.

- Product cost, quality and lead-time are correlated. Quality denotes the existence and performance of the product. However, paying high cost to get the product that exceeds the sell period converts to huge loss to the retailer.

- Fast fashion apparel is time sensitive and follow a very tight timeline and meeting the deadline is important than ever.

- Quality and lead-time go hand in hand. High quality products with simple design need shorter turnaround time compared to the embroidered or premiere fashion cuts.

- The time needed for the raw-material like fabric, trims or other accessories is important as that would define the timing of the European Scientific Journal November 2014 edition vol.10. Longer lead times generally tend to stock higher inventory levels for the retailers.

- Lead time reduction can lower a firm's overall costs and make it more responsive to the marketplace by decreasing the amount of finished goods inventory required.

- Lead time data is effectively a measure of the total manufacturing process. It tells how quickly raw materials can be converted into delivered product to the customer. Apparel manufacturing process is made up of many steps. Some of those involve a manufacturing process whilst many are just moving materials or product and waiting for materials or product. Having a high lead time is an indication that the process is not optimized.

## Methodology

A Delineation of the absolute lead time direction in Bangladesh* made garment industry involved intense consultations from occupied force in different sections. Lower information followed amassed from different multinational and local anesthetic explore articles. Genuine time data was collected from famous garment sourcing fellowships in Bangladesh. Consultations followed chosen from manufacture populate who accept cost bringing since age in the clothes deal. Judgements from the government activity insurance Jehovah* and related authorizations as if Bangladesh apparels manufacturing business and Exporters Connection (BGMEA), Bangladesh connection of Exporters (BAE) embodied cover checked off to control authenticity and reality of the assembled lower information. A view on 15 ready-to-wear fashion industry in the two apparels bundles, Gazipur and Narayanganj of Dhaka city and Chittagong (interface metropolis) were accommodative to display the debatable domains in arrears the extended lead-in time. Expert's notices constituted besides borrowed developing an important issue of the debatable countries. Issues and handling in the beginning of 1990s, the lead time cost 120-150 days but in 2007, them embodied came down by 30-50 daytimes, i.e. at present it is 90-100 a long time. China demands only 30 daylights due to their fabric and early rearward linkage quick nesses as well while exportation favorable direction and backing policy. They're 45-60 sidereal day in India and Pakistan.

Problematic areas in the readymade apparel industry that affects the lead time are primarily classified in three categories:

- Development Stage
- Execution Stage
- Other Areas

## Development Stage

This area comprises the order reception to the in-housing of raw materials and accessories. The obstacles in this section mainly cycles through backward linkages and buyer order processing systems.

## Backward Linkage

Backward linkage industry is said to be the industry who supplies the raw materials to readymade apparel industry i.e. the primary textile industry and the accessories industry. Bangladesh & Sri Lanka has gained enough reputation for knit fabrics as most of buyers are relying on local knit fabrics to produce their apparel products from Bangladeshi apparel industries. More than thousands of knit composite apparel industry is functioning delivering final products within around 90 days whereas the average lead time in the apparel industries are more than 110 days. The international standard though is far better. The Sri Lanka is 20-40 days & the apparel industries that do not have their own backward link industry have to source fabrics from local or foreign producers which requires an extended lead time. Fabric import is a lengthy process and on average takes up to 60 days.1In the woven sector where more than 90% of fabric is sourced from mainly China requires a lead time of around 120 days to ship the end product. In figure 1 the Gantt chart for a typical apparel industry shows that, in-housing the materials takes up to 40 days of the 90 Days of the lead time that is 45% of the total time (Table: 01). China in other hand do not comprise the burden of importing fabrics as they are rich in in-house textile solution, can ship the end product within a lead time of only 30 days.

(Table: 01) Average lead time for different types of industry

| **Type of Industry** | **Average Lead Time** |
|---|---|
| Knit Composite Industry | 70-90 |
| Knit Apparel Industry | 90-110 |
| Woven Apparel Industry | 120 |

## Buying Behavior

As an important hub for apparel sourcing, most of the apparel buyers of the world have a buying office here or carry out buying through middle retailers. Buyer's buying behavior is also identified as one of the reasons behind prolonged lead time. Manufacturers have limited access to current market intelligence and information on international apparel trade trends. There is no specific indication from the local buying offices to the manufacturers about the next season's fashion. In most of the cases there is not any opportunity for the manufacturer to plan in advance for fabric and accessories. Even the local buying offices are not the ultimate decision makers and approvals had to be taken on various stages of production like fit sample approval, pre-production sample approval, design approval, wash approval etc. from the headquarters. Samples are sent by air to the respective head offices and it takes much time. On various occasions, the buyer's authorized Approval person is not available immediately. These problems delay the decisions to be made by the buyer and add some undesired days in the lead time. Approval process is lengthy and consumes around 10% of the total lead time. If the local buying officers were given the authority to approve samples, approval process could have been completed within 2 to 3 days whereas it takes 10 to 15 days now. Cases are also common when sudden changes in style, color or shade are regulated in the middle of the production which requires new planning, new material requirement and sourcing and new work study; leads to prolonged lead time. Strategic sales forecasting of the renowned fashion brands are done in such a way that it allows barely any room to the manufacturers. Apparel brands want to meet the exact customer demand for the upcoming seasons. They are always in a mad race of showcasing the latest fashion trend in the market before someone else does. Doing so, they wait until the last moment to plan for the coming season and these forces them to have a little time on hand to produce the apparel. The explicit pressure applies to the manufacturers. They have to do so many things within a little time available.

## Execution Stage

Execution stage refers to the start of bulk production and receiving the final product. Though it seems as the major stage in an apparel industry, it only takes 15-20 days for the production of end product if the development of the order was executed effectively. Problematic areas that consume avoidable lead time in this stage are shown as followed.

## Inefficiency in planning

Planning in the execution stage is the identification of required manpower and machines to be able to complete the production in least time. It refers to the process of determining of manpower, equipment and facilities based on the demand. The four basic manufacturing metrics used in the industry are Cost, Quality, Lead time and Technical Risk. So, inefficient planning has a great effect on those four metrics.

## Backdated production system

The choice of best apparel production system should depend on the product and policies of the company and on the capacities of manpower. Sri Lankan apparel sector uses the traditional progressive bundle system widely where parts of various components after being cut in the Cutting Room are tied up in bundles and distributed out to the Sewing Section as bundle form. In this system balancing a line is difficult and an efficient supervisor is needed which is not available in every industry. Planning for each batch of each style takes a lot of time. This is somewhat an ineffective practice, as production managers are unable to manage or plan the Production effectively every time.

## Low Productivity

In Sri Lanka & Bangladesh, workers are available in plenty but lack of skill is still a big concern here. This yields low productivity when compared with other competitive countries like China, India, and Pakistan. If China's productivity is 100, Bangladesh's productivity is only 77%. Besides, lack of investment in new machinery and technologies with current insufficient size of skilled workforce also impedes an increase in productivity. Unskilled middle management positions are also a major reason behind the low productivity of apparel industry. Most of the firms are run by people with no previous academic background of textiles or apparel. Old-fashioned technology with non-technical persons is a common phenomenon in the apparel firms.

## Other Areas

Sri Lanka is a developing country and still weak in infrastructure compared to international standard. Poor supply of energy and gas, transport and port facility which are essential elements of international trade are still below part. And to add with the political instability, transport of readymade apparels to the destinations through the port sometimes becomes a lengthy process.

## Weak Infrastructure

Congested roads, limited inland transport alternatives, add inefficiencies to apparel export lead time. The apparel industry is highly dependent on the Southern highway route as Colombo sea port is the main doorway from the country. Most of the apparel industries are Katauanayake, Biyagama, Koggala, and Wathupitiwala. As a result of road congestion its difficulty keep the import consignment at the given time, the route is very important for apparel export. Expect Katunayeke other places are most 100-200 kilometers a way of the Colombo sea port& it takes a day long for a cargo to reach which is really inefficient. Many apparel exporters complained that they cannot meet the strict lead-time set by the international buyers due to this.

## Labor and political instability

Sri Lanka & Bangladesh apparel industry can supply the products at the cheapest rates as they have the cheapest labor in the offering. But there is always a pressure from worker trade unions to raise the wages periodically. And this pressure sometimes transforms into violent protests that forces factories to shut their operation. The instable political situation of the country doesn't help the cause and factories have to remain closed for weeks some times. As a result there are cases where manufacturers seldom miss the agreed lead time with the buyers.

## Proposal of a strategy for reduction of the lead time

Lead time in the Sri Lankan apparel industry cannot be reduced overnight, but if some strategic steps can be adopted it is possible to gradually reduce the lead time significantly. Current level is 20-40 day) of lead time can be reduced only by proper and efficient management in the supply

chain. And 15% (about 14 days) time can be avoided by only developing port & road facilities. Development of the textile sector is essential to reduce dependency on imported fabric. If local textile industries can supply quality fabrics to the apparel industry another 15-20 days can be alleviated easily. Solutions are proposed in three stages (immediate, mid-term and long-term) through this study and they are described below.

## Immediate solutions

Solutions those can be adopted right now in the apparel industry are termed as the immediate solutions. These are concerned with the improvement and modernizing of the current production system and supply chain management in the apparel industry. Regular training of workers and Application of ergonomics in the production floor should be implemented to boost productivity. Relation between buyer and manufacturer should be for long term and more open-oriented. The immediate steps that can reduce lead time considerably are described below.

Advanced production and management
Creating long term relation with the buyers
Mid-term solutions
Improvement of infrastructure
Improvement of port facilities
Political stability
Value added product
Long term solutions
Improvement of backward linkage industries

Key areas:
Mainly Cost, Order Changing, Line Balancing, Supplier selection

## Conclusion

Lead time is one of the major problems that the apparel sourcing world is facing when exporting readymade apparels is concerned. Apparel sourcing bodies are one of the major stake holders of the apparel trade and they along with the Government authorities can endow their investment in improving the factors affecting the lengthened lead time issue. The prevailing factors behind this are mostly related to the efficacy of the supply chain and port facility. The major back lock in the supply chain is the incomplete support of the primary textile industries that is supposed to supply the raw materials to the apparel industries, especially fabrics. Fabrics import from abroad takes up from 15-25 days of the average lead time. Improvement of the backward linkage industry to a standard to be able to support the apparel industries with export quality fabrics is a continuous process and it will take some time. However, the development of the production and manufacturing system can be implemented in a short while and it has a proven impact on the lead time. Buyers motive towards their suppliers should be more open oriented and decisions regarding sample approvals should be more efficient. Port facilities are only a question of time; as the export market is expanding, investors will be more attracted to develop the Colombo port to an international level. The China will be fruitful for both the manufacturers and buyers to explore in the global fast fashion industry with confident and competitiveness.

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## LIST OF ACRONYMS

AHP Analytic Hierarchy Process

ANP Analytic Network Process

CIPS Charted Institute of Procurement and Supply Chain

DSS Decision Support System

EDB Export Development Board

QFD Quality Function Deployment

SCOR Supply Chain Operations Reference

SEM Structural Equation Modeling

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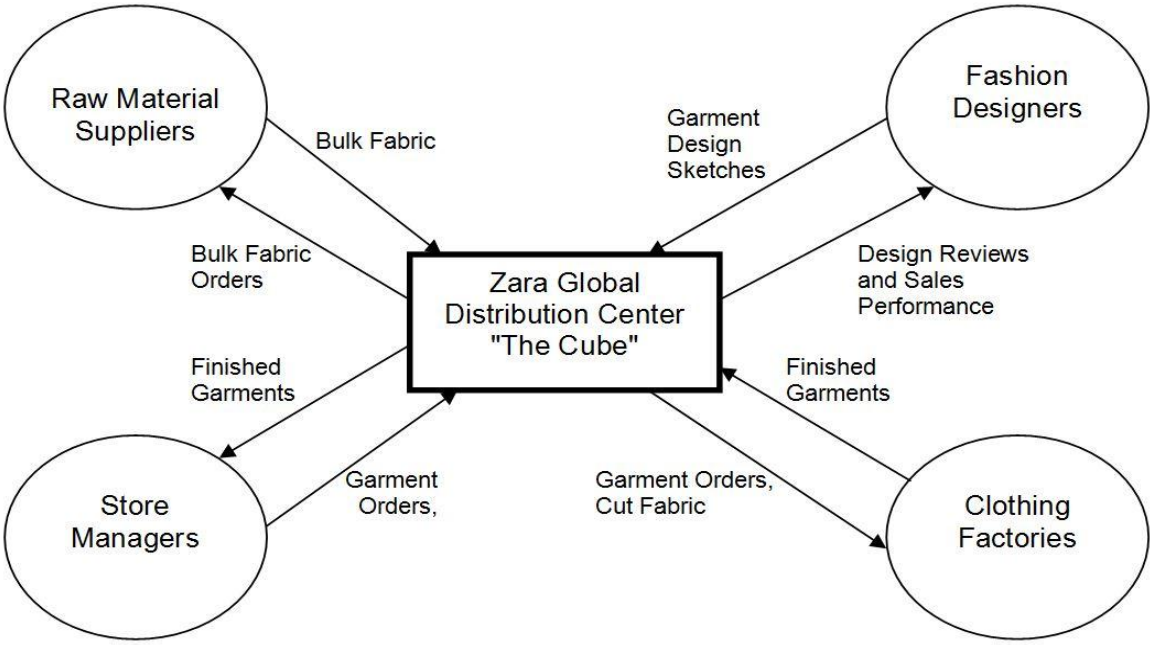
# CHAPTER ONE: INTRODUCTION

## 1.1 Background of the research

### 1.1.1. Introduction

The fashion and apparel industry encompasses a wide variety of garments and uses almost every type of textile manufactured. It is generally subdivided into two categories: clothing for men and boys and clothing for women and girls. According to Select USA, a service of the federal government, U.S. textiles, which includes the fashion and apparel industry, "is one of the more important employers in the manufacturing sector, representing 2% of the U.S. manufacturing workforce." The research group IBIS World reported that the global apparel manufacturing industry generated US dollars six hundred eighteen billion in revenue in 2015.




Source: SCM Globe Corp. (2016)

Figure 01: Manufacturing in apparels process

New York City is often seen as the heart of the U.S. fashion and apparel industry, and about forty percent of all salaried fashion designers are employed there. But California, Texas, and North

Carolina also account for a good percentage of all workers in the textile industry. The manufacturing side of the industry includes workers who produce apparel such as those who use patterns to cut a variety of textiles into apparel's individual pieces, and assemblers, sewers, pressers, and inspectors to create the apparel from the textile pattern pieces. Clothing production also requires the support of workers that include fashion designers to design the article of clothing; patternmakers to draw and construct a pattern for the garment based on the designer's specifications; merchandisers and retail buyers who place the apparel in stores; and retail salespeople who sell the finished garment to consumers (Figure 01).

Others who work in the fashion and apparel industry include fashion models, marketing and advertising professionals, and administrative and support staff. As of 2014, the apparel manufacturing industry employed around One Hundred Forty Thousand Eighty Six workers, according to the Department of Labor. Economically, the apparel industry is a key segment for investments, revenue, trade, and employment worldwide. Despite changes in how garments are produced and made available to consumers, which indicate declining employment opportunities in the manufacturing sector, many of the operations at apparel factories are difficult to automate because of the large variety of fabrics and the intricate cutting and sewing required of most fashions, so the fashion industry is likely to remain labor-intensive in coming years (Figure 02).

Trends within the fashion and apparel industry that may influence U.S. employment in coming years include consolidation of businesses in the retail sector, increased use of e-commerce by consumers, improved technology decreasing the need for garment manufacturing workers, and the continued use of cheap labor in countries such as China to produce apparel. Select USA, however, reports that the U.S. textile industry remains competitive, ranking fourth behind China, India, and Germany in global export value. According to Select USA, U.S. textile exports saw an increase of 45 percent between 2009 and 2014, with more than 60 percent of those exports shipping to countries that are partners with the United States in free trade agreements (Figure 03).

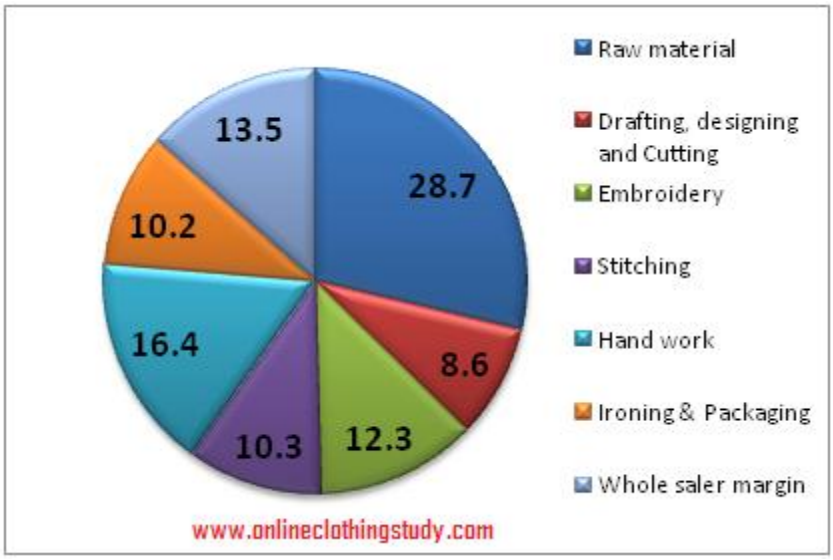



Figure 02: The contribution of labor related work in garment industry

### 1.1.2. The History of Garment and Apparel Industry of Sri Lanka.

The apparel industry is the single largest source of export revenue to Sri Lanka. It accounts to about 50% of total exports from the country and employees 15% of the country's workforce. Even though the textile and apparel industry started to spread in the island in 1950s, it was to Accommodate the local demand and was heavily backed by the government. In the 1960's established manufacturer's shifted their attention to the export market. As a result in 1965 Huntley Garment Ltd. managed to send the first batch of ready-made garments, a shipment of shirts from Sri Lanka to the USSR. This was under a bilateral trade agreement between the governments of the two countries. Apart from Huntley eleven other pioneers who took the industry to the next level can be identified. They are Bernard Bateau, Valona, Hirdaramani, Bentley Industries, Lanka Weaving Mills, Ceylon Dia Shirt Company, Candy Garments, Ceylon Knit-Wear Industries, Noortex Garments, Maxims, and DM industries.

When the new opportunity showed signs of a lucrative future the government was more interested in inviting foreign manufacturers to start plants in the country. After the political reforms in 1972 the highly protectionist and hardline restrictive economic policy that prevailed in the era

encouraged the pioneers of many local industries to achieve the government's goals of a self - sufficient economy (Figure 2). It also shifted its attention to a more export oriented economy. As a result East Asian manufacturers were lured into the country by providing both financial and non-financial incentives including tax holidays. In the early 1970s the government introduced the Local Investment Advisory Committee (LIAC) to back up the export oriented industries (Figure 4). Through this initiative special forex allocations, fiscal and tax incentives were provided for selected 2500 companies including 2000 textile and apparel related industries (Figure 6). This trend was further strengthened with the signing of the multi-fiber agreement (MFA) in 1974.

This agreement which was very impactful for the global textile and garment industry governed the world trade in the sector from 1974 to 2004. It introduced a quota system according to which the trade was governed for three decades. By this time textile and garment industry was no more a profitable industry in the Western Europe and the America basically due to high wages which led to high production costs. Although the MFA can be considered as a short-term protectionist measure taken by developed countries to back up their local industries preventing a sudden extinction, it was a very favorable turning point for some developing countries including Sri Lanka. At the same time some other developing countries lost their export income due to shifts in manufacturing.

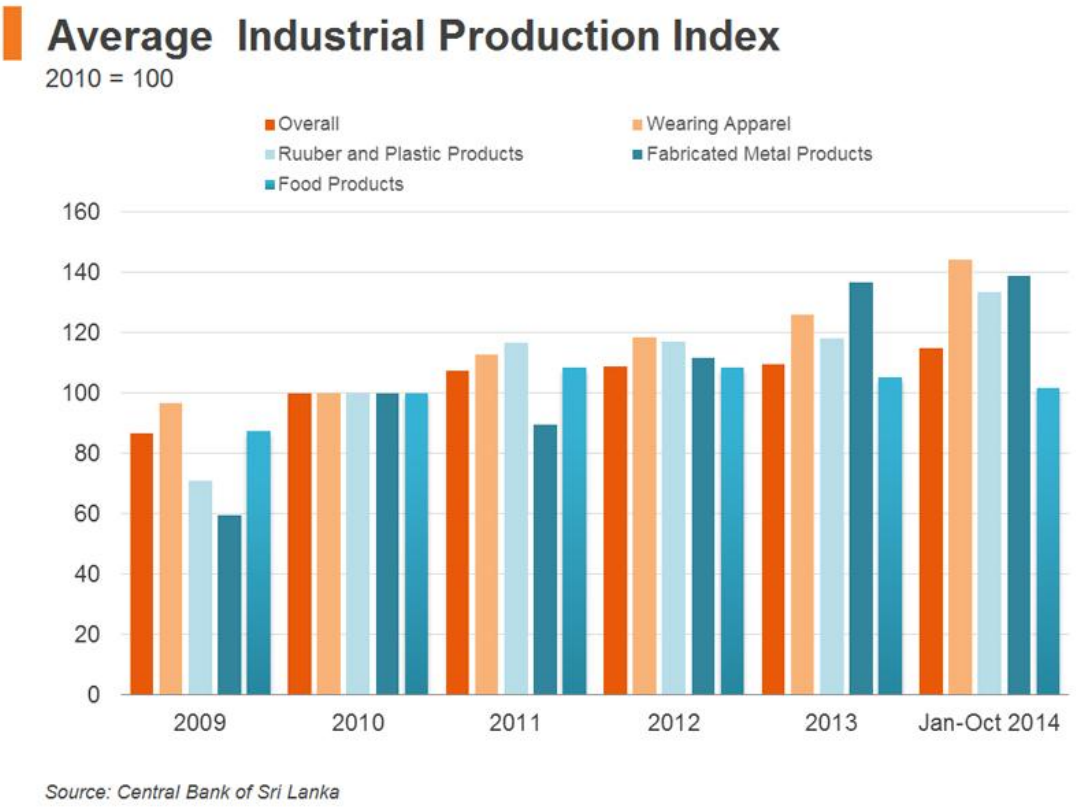



Figure 3: A comparison of garment industry production with other sectors

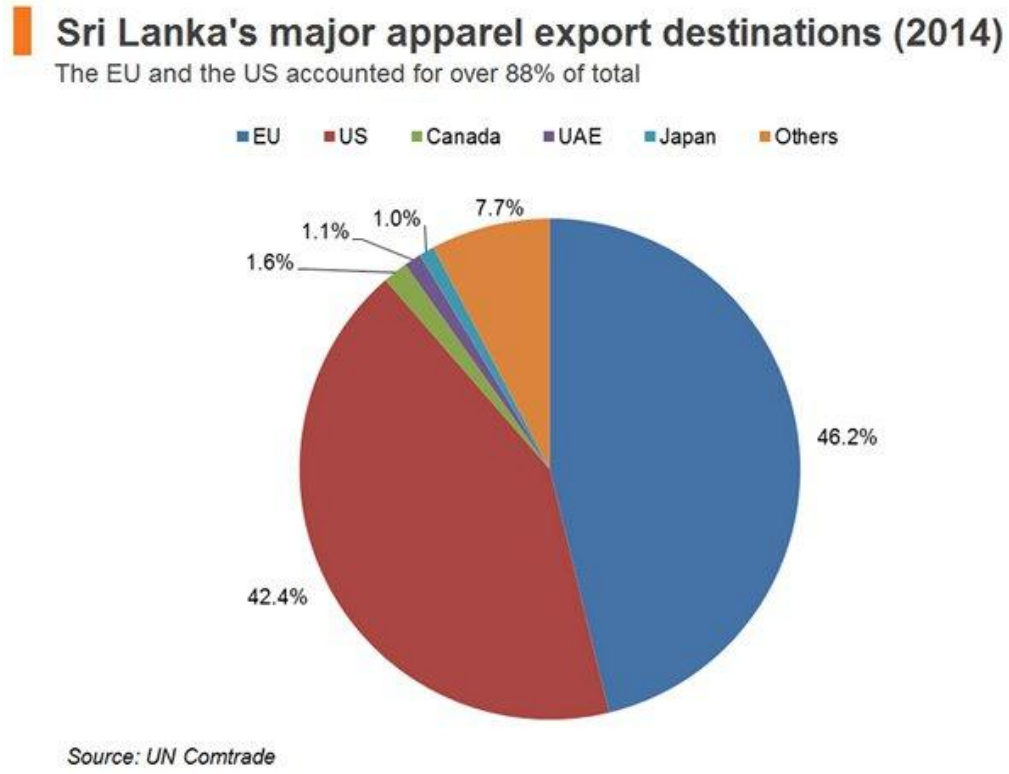



Figure 4: Sri Lanka's major garment export destinations

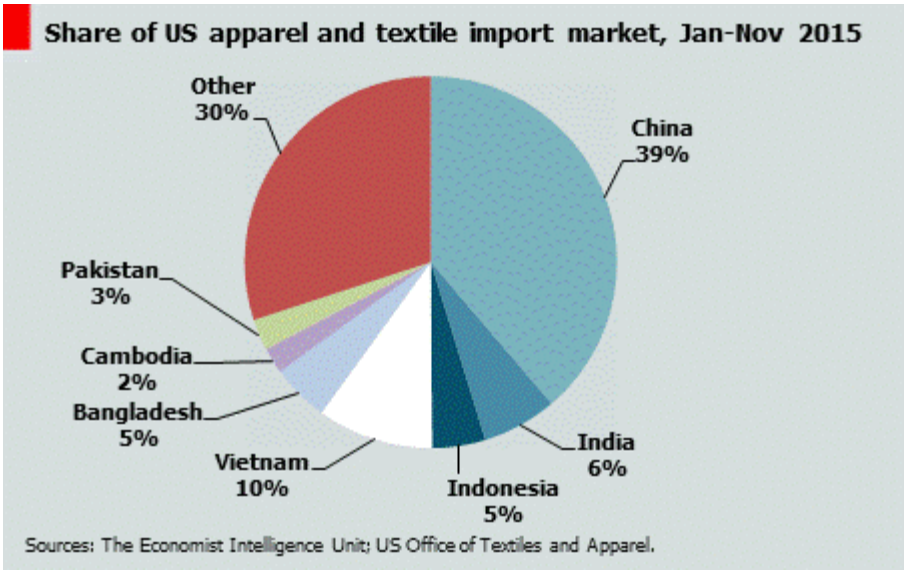



Figure 5: US garment import share from producing countries

### 1.1.2 Problem Statement/Need for the study

In Sri Lankan context, there are no research was founded with regard to the developing of the "Lead Time" in apparel manufacture industry. It is highly emphasized by professionals and researches to develop analytical models to lead time. (Shahidul Kader, Maeen md, & Khairul Akter, 2014). And it becomes necessary for the Sri Lankan Apparel industry to adapt to new methodologies for this term. According to past literature with similar research topic, it is found that the list of criteria and the relative importance of each criterion are tuned with changes in time and also with changes in business environmental factors (Figure 6).

### Research Gap

In the beginning of 1990s, the lead time was 120-160 days but in 2007, it was reduced by 20-40 days in Sri Lanka, Bangladesh 90-100 days. China 40-60 (requires only 30 days due to their textile and other backward linkage facilities) where the India & Pakistan 45-60 days to complete an order.

Type of Industry Average Lead Time;

Knit Composite Industry 70-90 days
Knit Apparel Industry 90-110 days
Woven Apparel Industry 120 days

**Shipping Time from Colombo Port to Selected Locations**

| Port | Time to Take |
|---|---|
| Tuticorin, South India | 8 hours |
| Chennai, India | 2 days |
| Mumbai, India | 4 days |
| Singapore | 3 days |
| UAE | 5 days |
| Sydney | 11 days |
| Amsterdam | 18 days |
| New York | 21 days |

*Source: Board of Investment, Sri Lanka*

Figure 6: Transit days of the selected destination

Moreover, study results are sensitive to time changes. On the other hand, it could be noticed that previous researches on the similar topic covering Sri Lankan setting are not in existence. Gap identification led to the origination of the research problem and ultimately the present study has contributed to add new knowledge to the existing literature and new technique for the Lead Time in apparel industry in dynamic situation of changing order.

## Research Problem

The main focus of this research is to develop a model in Lead Time perspective of Sri Lankan apparel industry to cope up with the dynamic situation of order finishing cycle.

**How to minimizing the Lead Time with given order cycle (optimum time duration)**
**In the Sri Lanka modern apparel sector.**

## Research Objectives

The research objectives are achieved through the analysis of the literature reviews, questionnaires given to the Logistics professionals in the Sri Lanka apparel industry. There are three research objectives which are to be accomplished at the end of the project.

- To analyze the SCM in the textile and apparel sector and assess the current SCM in terms of total lead time in the apparel sector.

- To explore the backward and forward linkages and integrated relationship among the supply chain parties.

- To explore the potentials of SCM and to build a new effective supply chain for CMT (Cut Make Trim) based apparel sector for minimizing lead time in the face of new global apparel.

**Research Process**

| | |
|---|---|
| Literature survey | studying the relevant literature reviews to identify research problem and background knowledge of the study<br>Define research objectives |
| Pilot study | studying the apparel industry of Sri Lanka to identify the nature and variations of supplier selection procedure and identify the scope of the study with limitations |
| In depth study of theoretical Aspects | To identify significant Lead Time criterion and the methods of developing model |
| Preparation of questionnaire - stage 1 | Prepare, do the pilot survey and correct the questionnaire and send them to procurement professionals in apparel industry |
| Sample selection and data Gathering | Select 40 valid responses. Online survey, Pilate survey & interviews |
| Identify Lead Time criteria | Using Pareto analysis, identify criteria |
| Conclusion | Model for lead time and further recommendations |

## Research Scope

Each and every industry, Lead Time is a main process because each and every tier in supply chain management is a supplier for next tier. When it comes to the literature in this particular research area, several researches can be found in the global context. Even though such researches can be found in the literature, it is doubtful whether these research findings can be applied to the Sri Lankan context as the factors affecting the findings vary in a large scale as the countries vary. This leads to a problem when the findings are generalized and so, Sri Lankan context has been chosen for this research.

When consider about the apparel industry, there are different scaled companies as X-large, large, medium and small. It is difficult to focus on all the three scales and there is no appropriate list for it. So that, the list that provided by National Export Development Board was selected as the population for the research. It consist details of forty companies in the apparel industry. In order to gather the data, logistics professionals and knowledgeable persons of selected companies was contacted. As for the above mentioned reasons, the basic scope of this research is the eighty listed companies in apparel industry listed in National Export Development Board in Sri Lanka to develop the lead time model in dynamic situation. The ultimate outcome is a decision support model for lead time in context of apparel industry in Sri Lanka.

## Chapter breakdown

Chapter 1

Gives an overview about the background of the study area with the brief introduction to apparel industry in Sri Lanka. The need for the research, research problem and objectives are identified and the significance of the research is justified. And scope and the limitations of the research are focused. Through the chapter 1, reader will understand the basic idea of the research and the importance of the research.

Chapter 2

Structured to establish the theoretical framework for the research and identify the suitable lead time criteria. And this chapter is the basis for identifying the analyzing method and the methodology. This consist the previous literature reviews and their findings with relevance to this research.

Chapter 3

Explains the methodology used to reach the research findings. This will explain the research design, data gathering methods used population, sample design and the analysis method. A comprehensive idea about designing of the questionnaires can be gained after reading this chapter and the analysis methods has been explained in detail.

Chapter 4

Present research findings. It includes descriptive analysis of the demographic factors of apparel industry relates to lead time process and the model development using Pareto analysis and AHP method. In order to validate the lead time selection model, case study was analyzed and run the model. Besides that the decision support framework relates to proposed model and comparison with typical lead time process are presented in this chapter.

Chapter 5

Structured for the conclusion and future research directions. It consist summary of research findings, recommendations, research limitations and future research directions.

# CHAPTER TWO - LITERATURE REVIEW

## 2.1 Supply Chain Management: The concept

A supply chain is a system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to end customer. Supply chain activities transform natural resources, raw materials and components into a finished product that is delivered to the end customer (Figure 7). The supply chain process for manufacturing and service industries started with suppliers, manufacturers, distributors, retailers, customers and suppliers, service providers, customers and end with consumers respectively. The customers are the most vital focal point of the supply chain, since the primary purpose of the existence of any supply chain is to directly or indirectly satisfy customer needs. In every manufacturing organization, for their working purpose they follow the basic supply chain. The following diagram is the basic supply chain for manufacturing organizations. The basic supply chain of readymade apparel industry in Sri Lanka are involves supplier, manufacturer, ultimate buyer and service provider.

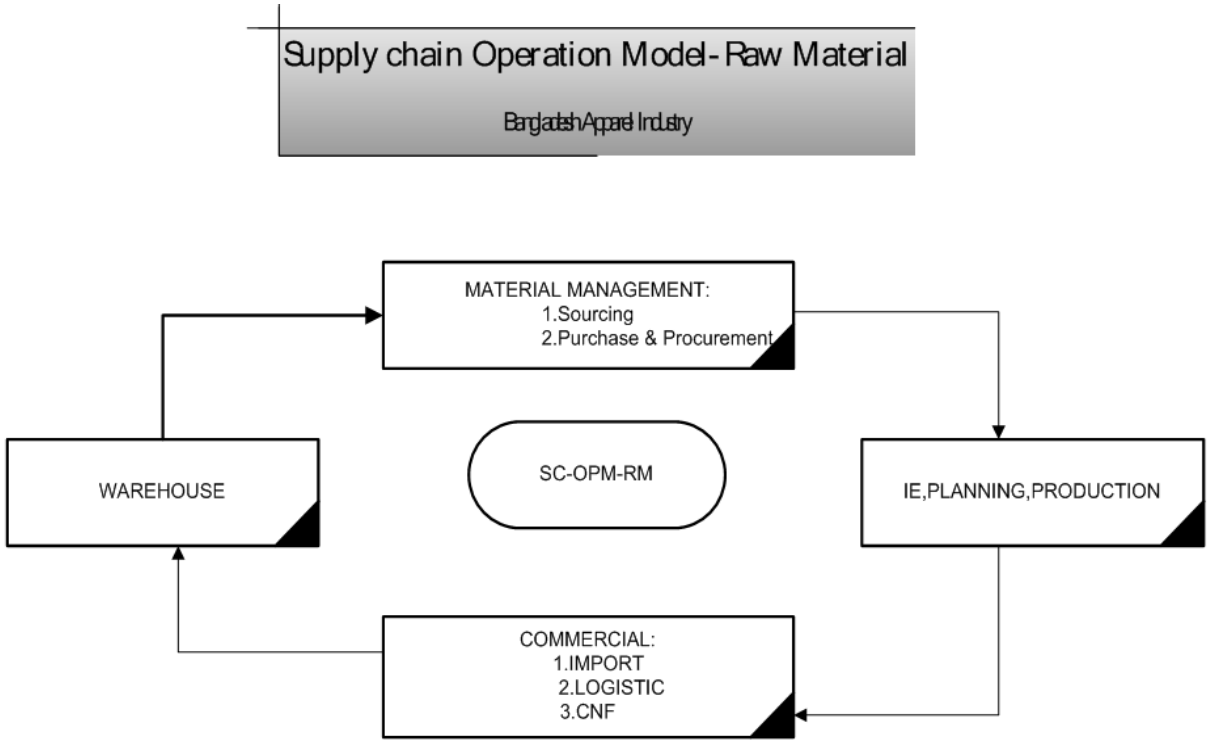



Figure 7: SCM in apparels sector

### 2.1.1. Supplier

Fabrics & Trims, Packaging producers are defined as supplier in garments industry. All the fabric woven & knit can be sourced from around the world some time the fabric, accessories and packaging item procure by local suppliers.

### 2.1.2. Apparel Company

Apparel manufacturers in Sri Lanka can be categorize as follows;

- Customer Phase 1: Retail Branding Owner VS, H&M, M&S, GAP, ABACOMBI etc. All the apparel brands are in this phase. They are the main buyer and acted as a customer and they merchandise all the garments and distribute it through DC to available for consumers.
- Customer Phase 2: Merchandise organization or buying house. In fact, all the merchandise organization and buying house working as a middleman between buyer and garments factories and for this service, they earn commission.
- Customer Phase 3: The Branding Owners (Caledonia S.P.A) put up an apparel companies in locally and they produce the direct orders to the owner. And, the owners enjoy the more profit when the retailing the product to Europe.

### 2.1.3. Ultimate Buyer

Consumer (who buys the product for ultimate use) is the most vital point for value chain in garments industry. All the works have been done for meeting the consumer needs in the in this supply chain, there is another part that provides the service & worked as helping hand for the manufacturing organization.

## 2.2. Supply Chain Management in Sri Lankan Apparel Industry

Sri Lanka initiated export oriented readymade garments production from 1970 onward. After liberalization of the economy in 1977, the apparel industry in Sri Lanka took off mainly based on quota-hopping. East Asian exporters relocating their established business to Sri Lanka. Currently, apparel manufacturing industry in Sri Lanka is the largest industrial sector accounting for 43.2% of total exports and 56.4% of industrial product exports. Ready-made garment exports from Sri Lanka account for close to 95% of all textile and garment exports for prestigious international brands such as GAP, Marks and Spencer, Victoria's Secret, Abercrombie and Fitch, Liz Claiborne, labels such as Tommy Hilfiger, Ralph Lauren, Pierre Cardin, Intimissimi & Tezenis etc. However, heavy reliance on ready-made garment manufacturing for growth and development has made the Sri Lankan apparel manufacturing industry vulnerable to global economic shift and policy changes such as elimination of the MFA in 2005 and the global economic meltdown in 2008. The industry is mainly depending on imported raw materials such as fabric and accessories (80-90% fabric, 70-90% accessories) therefore severely hindering production speed and increasing lead-time. Industry challenges include increased international competition, backward integration, low worker productivity, shortage of labor, high production cost, and government interferences on wage structures and taxation policies. These issues aside, the apparel industry in Sri Lanka is reputed for ethical manufacturing and known to the world as a producer of "garments without guilt" by launching world class environmentally friendly factories, free from child or forced labor and sweatshops. Additionally, well-established industrialists have made a mindful effort in specializing in high value-added "niche" products. Consequently exceptional export growth has been seen in certain product categories. The industry is one of the most prominent in Sri Lanka and is attractive for female workers, resulting in high potential in creating job opportunities for the poor in the country. Eighty per cent of apparel works in Sri Lanka are female, and employment affords them opportunities for greater social wellbeing, for example through access to better health care and education for their children. As Lopez-Acevedo and Robertson highlight, more can be done in order to realize Sri Lanka's potential to be a regional clothing manufacturing hub in order to create more jobs and increase opportunities. The apparel industry in Sri Lanka overtakes other South Asian countries in terms of product quality, "lead time (20-45 days), reliability, along with social compliance and sustainability". As Lopez-Acevedo and Robertson highlight, China

gradually decreasing its apparel manufacturing (Figure: 8) therefore Sri Lanka has potentials to gain global apparel manufacturing market share as investors seek out apparel firms in Cambodia, Indonesia and South Asian countries. The apparel prices in Sri Lanka are higher than competitors compared to other regional apparel exporting countries, however Sri Lankan firms produce more sophisticated products, ensuring the industry remains competitive.

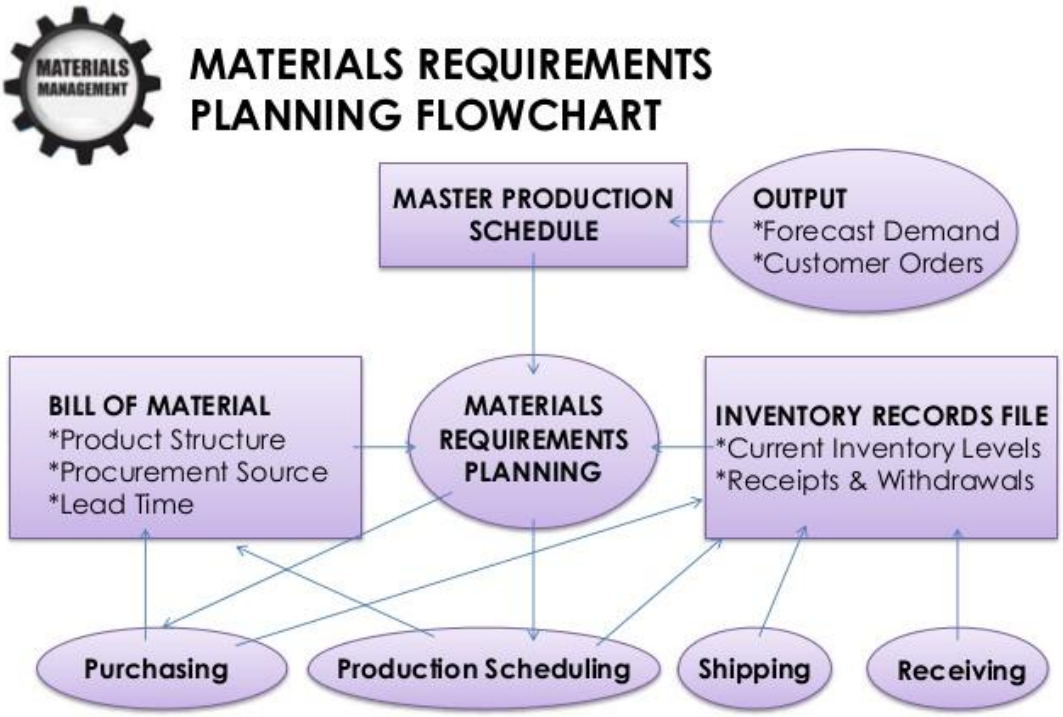



Figure: 8 Chart Time Line Material Flow

**2.4 Generalized System of Preferences (GSP) Plus**

GSP Plus offers incentives in the form of duty reductions on exports as a reward to developing countries for their commitment to upholding the 27 core international conventions on human and labor rights, sustainable development and good governance. Then the country must also be considered 'vulnerable' under two conditions – the country is not competitive in the EU market (the import-share ratio is less than 6.5 percent of the EU's total GSP imports) and the country does

not have a diversified export base (seven products account for over 75 percent of that country's total GSP imports to the EU). There are currently eight other GSP Plus beneficiaries –Armenia, Bolivia, Cape Verde, Kyrgyzstan, Mongolia, .Pakistan, Paraguay and the Philippines Another important aspect of the current GSP Plus scheme that gets less attention is the ability of countries to make use of 'regional cumulating' to gain advantage of Rules of Origin (ROOs) in instances where the product input cannot be sourced locally. Regional cumulating encourages regional co- operation amongst those countries that are both GSP beneficiaries and members of a regional grouping recognized by the EU. There are two main types of regional cumulating that can benefit Sri Lanka – SAARC Regional Cumulating and Cross Regional Cumulating – e.g. between SAARC and ASEAN. Sri Lankan exporters should study the possibilities of regional cumulating in their supply chains in order to maximize what GSP Plus can offer. Sri Lanka will continue to be eligible for GSP Plus as long as the periodic reviews (the first one coming in two years) by the EU do not raise any red flags with regard to the implementation of agreed human rights and governance reforms. Yet, once the country graduates to an 'upper-middle-income economy' status (as classified by the World Bank) and remains at that classification for three years, then Sri Lanka becomes no longer eligible for GSP Plus (with a grace period of around two years). Moreover, at that stage, Sri Lanka would no longer be eligible even for the regular GSP scheme. Sri Lanka's graduation will of course depend on our growth rates over the next few years (slower growth would mean longer time to graduation), the value of the currency (sharper depreciation against the US dollar would mean longer time to graduation) and the country classifications of the World Bank (which are revised annually under the World Bank Atlas Method, in line with global Purchasing power parity levels.

### 2.4.1 Potential gains from GSP Plus

The primary way in which Sri Lanka will gain from GSP Plus is by our exporters having duty free access to the EU market on a whole range of products, which were previously only under a preferential tariff through the GSP scheme. The additional tariff advantage will greatly strengthen Sri Lankan exports' relative competitive position in the EU. Sectors like apparel, processed food products, seafood, toy products, porcelain and ceramic ware, are some of the main sectors that will benefit under GSP Plus. The additional tariff concession gained by these sectors will vary – in

many apparels categories duties are cut from 9.6 percent to zero, in the seafood sector from 18.5 percent to zero, in the fresh and processed fruits and vegetable sector from 12.5 percent to zero, in the porcelain and ceramic ware sector from 8.4 percent to zero and in the toy products sector from 1.2 percent to zero. Regaining the GSP Plus facility is expected to give a major boost to Sri Lanka's top export product, apparel, which claims the lion share of total exports to the EU (61 percent). Our calculations on 2016 exports in nine HS categories in the apparel sector (covering around 40 percent of total apparel exports to the EU) estimate that this additional reduction of tariffs under GSP Plus is valued at around US $ 60 million. Our discussions with apparel exporters over the last two weeks indicate that more EU customers would now change their sourcing strategy (which currently is tilted towards duty free countries like Bangladesh and Cambodia) in favor of Sri Lanka. Given that ROO under GSP Plus requires fabric to be sourced from Sri Lanka (or from an area that qualifies for regional cumulating) in order to qualify for GSP Plus, there will be an increase in demand for fabric sourced from Sri Lankan fabric mills, rather than from countries such as China. While it is difficult to provide a full analysis of what was lost, looking at how Sri Lanka's competitors fared in the EU market, give some sense of how Sri Lanka lost out to Asian apparel exporters. According to the International Trade Centre, Vietnam, Pakistan and Cambodia all trailed Sri Lanka in 2009, with EU exports at US $ 2.1 billion, US $ 1.5 billion and US $ 1.09 billion, respectively, against Sri Lanka's US $ 2.3 billion. By 2015, however, Vietnam's apparel exports to the EU had risen to US $ 3.9 billion, Pakistan's to US $ 2.9 billion and Cambodia's to US $ 3.7 billion, with Sri Lanka trailing at US $ 2.4 billion.

### 2.4.2. GSP Plus amidst EU growth recovery

The regaining of GSP Plus is especially timely as the EU economies are beginning to show signs of economic recovery, which will hopefully improve demand conditions for Sri Lanka's exports to the EU. As the Economic Intelligence Unit's Monthly Economic Update for March 2017 observed, headline data is showing positive momentum in the Eurozone's economic recovery – for instance, 15 consecutive quarters of gross domestic product (GDP) growth. The latest Spring Economic Outlook of the EU Projects 1.9 percent growth in 2017 and 2018, up by 0.2 percent and.0.1 percent, respectively following the economic crisis, high unemployment rates in the EU had been a severe dampener on economic activity and consumer demand. The fact that this is now

declining is certainly a positive sign. Unemployment in the EU has been trending downward and is expected to fall to 8.0 percent in 2017 and 7.7 percent in 2018, the lowest since late 2008. This has been a result of rising domestic demand, structural reforms and other government policies in certain countries that encourage robust job creation. Private sector investment was at a six-year high in February, although political uncertainty continues to weigh heavily on economic prospects. A good signal of the region's economic recovery will be the European Central Bank (ECB), decision on renewing or not, its stimulus lending programmer set to expire shortly.

### 2.4.3 Industry Perspective

In order to get a quick sense of how the GSP Plus is likely to boost key export sectors, we conducted in-depth interviews with industry leaders in these sectors and asked specific questions, for instance on how their order books would change as a result of GSP Plus; how much of the additional tariff advantage would be retained at home; and what challenges they may face in meeting new demand. Leading apparel exporters have reported to us they anticipate a 10-15 percent boost in export earnings in the 12 months following the regaining of GSP Plus and will particularly accrue to smaller players in the sector. One large exporter was confident that the apparel industry would be able to achieve over a 25 percent increase in export volumes over 18 months.

Given that most contracts have already been finalized for the year 2017, the real benefits will be seen in 2018. Yet, some expect a 4-5 percent bump in 2017 itself. It is not just the apparel industry – there are big gains likely to be made in other export categories such as fresh and processed vegetables and fruits. One agro products exporter noted that their company "could expand their export volume to the EU by more than 50 percent within a short period". The industry leaders in this sector observed that the benefit of the 12.5 percent tariff reduction would be a three-way split among the customer, exporter and the farmer with as much as 50 percent of it going to farmers (at least 10,000-12,000 registered farmers they work with) as they believe in strengthening the supply is key to ensuring sustained supply for the EU exports. This demonstrates the possible impacts on rural livelihoods. from regaining GSP Plus Several companies noted that they are already in contact with the EU buyers who have shown positive signals on placing new orders as soon as

GSP Plus is reinstated. One exporter mentioned that his current export volume of processed vegetables could be increased from the current level of five to six containers to. About 30 containers per month they are confident on overcoming production capacity constraints by doubling the work shifts and automating the production process. Sri Lankan exporters in these sectors can exploit the potential for agro-based processed food exports in collaboration with European companies through joint ventures and transfer of technology. Meanwhile, the seafood exporters were upbeat about regaining GSP Plus as it will bring an 18 percent to 23 percent reduction in tariffs and the current export volume of US $ 230 million could be doubled within this year. Yet, they cautioned that the noticeable decrease in live fish in the Sri Lankan deep waters is posing a threat to the medium to long-term ability of the sector to meet new demand. Exporters of bicycles to the EU market noted a likely 50 percent boost in orders but will be only experienced in 2018, given the three to six-month order cycle and the exporters of porcelain and ceramic ware expect GSP Plus to boost exports by 5 percent to 10 percent over the next 18 months.

### 2.4.4 Challenges to overcome

Some exporters anticipate capacity constraints by way of labor shortages, particularly for small and medium enterprise (SME)-level exporters. This issue was raised by the sectors ranging from apparels to ceramics. Rather alarmingly, several exporters we spoke with have not taken initiatives to expand their production to prepare for the new demand. The government has a role to play in helping the SME exporters boost production quickly and leverage on the GSP Plus opportunity, than be held back by capacity constraints. The exporters who had shifted their export focus away from the EU market over the last seven years, since the loss of GSP Plus, acknowledge that regaining their presence in the EU and restoring the market share cannot be achieved overnight and it will take time. Once again, this is where the government authorities like the Export Development Board (EDB) and our diplomatic missions in the EU countries can help the prospective exporters with finding new partners and help to quickly break back in to the EU market. Many apparel and ceramics exporters also observed that the looming ‘Brexit’ could have a negative impact on realizing GSP Plus benefits fully. In apparels, for instance, the UK accounts for more than 40 percent of total exports to the EU. The government would need to move early to

forge a deal with the UK; if a bilateral free trade agreement (FTA) would take time, Sri Lanka can lobby for the UK to grant the GSP Plus-type access to the UK market for Sri Lanka exports.

### 2.4.5 Concession shouldn't breed complacency

It is important that the Sri Lankan exports sector use the GSP Plus period as 'breathing space' rather than 'comfort zone'. The government can consider launching a targeted, accelerated and cost-effective programmer to support export sectors capable of expanding their exports to the EU. This can range from loans for technology upgrading and innovation; targeted support for market development, skill training and labor attraction schemes; support for quality and standards Improvement; and fast-tracking approvals and certifications. Sri Lanka must use this window to boost competitiveness of our exports to the EU and not be complacent. As the country fast approaches the 'upper-middle-income' status and will thereafter not be eligible for GSP Plus or GSP, building export success beyond the concessionary scheme is crucial. (Anushka Wijesinha and Jayani Ratnayake).

## 2.5 Analysis of Supply Management of Apparel Orders

Apparel buyers around the globe demand product as they want it, when they want it, and the best possible price. In today's highly competitive global marketplace they are placing greater value on quality and delivery time. Manufacturers similarly have begun to place more value on quality and delivery time and companies are trying to gain a competitive edge and improve profitability through cutting cost, increasing quality and improving delivery. However it is safe to say that the more competitive the industry, the more shortened lead times will help. In competitive industries, short lead time will differentiate a company from its competitors, leading to increase sales (Chariest J. Murgiano, CPIM).Lead time is one of the main competitive factors among companies. The ability to deliver quickly influences export, sales and thereby revenue. The definition of lead-time can vary, depending on what part of the company is focused upon. It normally includes all activities from start to end. Lead-time begins with the first receipt of a customer order and ends with customer receipt of the product or service. Everything in between is the lead-time (2004, elsmar.com). Lead-time refers to the time lag between placing an order and receiving it (Li, 2000).

In this study lead-time is defined as the time it takes from getting order from a customer and received the delivered product by that customer (Azad, 2004).

At present, Bangladesh the average lead time is 90-120 days. It is sometimes 100-130 days. Total lead-time is made up of time devoted to processing orders, to procuring and manufacturing items, and to transporting items between the various stages of supply chain. They are manufactured or arrive from Suppliers (David Simchi et al., 2000). Lead-time typically includes two components: ***Information lead times*** (i.e., the time it takes to process an order) and ***Order lead times*** (i.e., the time it takes to produce and ship the item). ***Information lead time*** can be reduced by using very sophisticated and modern communication system while ***Order lead time*** can be reduced through efficient supply chain management (Simchi-Levi, David, 2000) A researcher named Marc Smith explained lead time in two ways (www.elsmar.com, 2004). First, ***Customer lead time***, which refers to the time span between customer ordering and customer receipt? Second, ***manufacturing lead time***, which refers to the time span from material availability at the first processing operation to completion at the last operation? In his paper Marc Smith developed theories for the reduction of lead time in the equipment manufacturing company especially in vehicle manufacturing company. It is also applicable to the RMG sector. In the lead time reduction process, Lead Time Management in the Garment Sector of Bangladesh: An Avenues for Survival and Growth. Identifying the beginning of the process and walking through the process is very important. In the RMG sector after order confirmation the process begins by sending information to the suppliers for Raw materials (fabrics + accessories) and the process run through shipment of final product Received by the buyers. The whole of this process is comprised of the following steps – order Submission, scheduling & sequencing, manufacturing and distribution. A manufacturer may be able to reduce lead time by taking some strategic measures in all of these four stages. From the above theory it is clear that the total lead time is customer lead time. Therefore we can write that;

**Customer Supply time** = [{Information supply time} + {Order lead time}]

**Total supply time** = [{Information lead time} + {(manufacturing lead time) + (shipping time for import fabrics) + (Shipping time for export final product)} (**Note** that, shipping time for import includes shipping time, unloading time and transport time from port to manufacturing point. Shipping time for export includes manufacturing time for final products and shipping time for

export) the leading time on delivery issues matters most important in RMG export trade. In the beginning the leading time was 120-150 days, but now in 2008 this time has been reduced to 40 to 60 days, thanks to the timely intervention of the join forces. China requires only 30 days due to their textile and others backward linkage facilities as well export friendly policy. Bangladesh need set-up a central bonded warehouse for woven and grey fabrics in order to help the manufactures collect the fabrics within seven days from the issuances of L/C and thus reduce the lead time.

### 2.6 Manufacturer Lead time

Total supply time = [{Information lead time} + {(Order lead time)}] Or, = [{Information lead time} + {(time to manufacturing fabrics) + (time to shipment of fabrics)+(time to unloading fabrics and customs formalities at port) + (time to take fabrics from port to manufacturing point) + (time to sample approval and production of final product)+ Time to shipment or export of final products)}] Or, 120 = [{7} + {(15)+ (25)+(14)+(6) + (23)+(30)}] From the above equation, we can say that through the first four stages a manufacturer received fabrics from the suppliers after 60 days on average. Out of this the shipping time of 25 days is constant. There is no chance to reduce this shipping time but we can reduce the rest 35 days. There are two parties and various activities involved between suppliers and manufacturers in the supply chain. It can be seen in the (Figure 9) broadly. The activities and time consumption area have been illustrated here through four boxes (A-D) or stages.

- Supplier received order for fabric
- Manufacturing Fabrics & Shipment
- Unloading Fabrics at sea Port
- Manufacturers plant / Warehouse

Figure 9: Lead-time and fabrics importing process

## 2.7 Summery of Literature review

Bangladesh has emerged as an important supplier of quality readymade garments in the global market. The spectacular growth of garment sector in Bangladesh in recent years has dramatically changed the landscape of export composition of the country **(**Nuruzzaman & Ahasanul Haque). Sri Lanka also the main player of the international market with the shorter lead time & fines quality garments supplier in the fashion garment industry. Heavily dependent on exports of products & the economically impact to the GDP of the every year, as per the Sri Lanka market profile GDP growth eased to 4.3% in 2016 with the economy projected to stabilize somewhat with a GDP growth of 4.5% in 2017 Two major export items, textile and garments (45% share) include the US, UK and EU countries. Nevertheless, GSP facilities and new provisions of EUORPE. In this study attempts have been made to find out the ways to face the competitive business environment by the efficient management process towards the lead time reduction. The main purpose of this article is to analyses the business process of the garment sector to find out its lead time minimization process. The study has been concluded by the development of a new diagram of business process with the outcome that the other management process in the supply chain is an important factor rather than process management in the lead time minimization process.

Through the rapid innovation of technology and increasing affordability, it was transformed from %a means of convenience to indispensable tools for work, socialization, entertainment, and learning. Given the relevance of the topic, the purpose of this study was aimed to explore the contribution of supply chain technology adoption in Malaysian textile and apparel industry (Klee & Hassan, 2016). The lead time connectivity with the technology. It depend on the organization to organization. However, innovation technology is the best way to reduce the lead time within the factory premise, such as tag calculation of the each operator to help to count the pieces they made and can get an idea of the production of the each employee.

The study considered the apparel companies based in India to determine the supply chain management (SCM) techniques applied by these businesses as well as the benefits and difficulties encountered with its application thereby analyzing the effectiveness of the SCM in apparel industry (Sanil & Ramakrishnan, 2016)**.** Lead time questionnaire was used as a research instrument for this study to describe and assess the SCM systems of the selected apparel company executives.

Structured questionnaire was distributed to the selected company executives involved in the supply chain activities. The questionnaire which evaluates seven different dimensions of SCM systems was given to the respondents and the effectiveness of the SCM practices of the apparel companies were measured in order to determine whether its systems are beneficial to the industry or not. Based on the findings it can be concluded that the apparel companies obtained a number of advantages out of SCM application with reference to the efficacy and responsiveness in delivering the goods or services to the customers.

Khan, (2016) aims at identifying the sustainability issues in sourcing process and to identify the core competencies in sourcing process through triple bottom line adaptation. The focus of this thesis is on apparel industry's sourcing process. The purpose of this thesis is to examine global apparel industry's reality in their sourcing process and how buyers-suppliers are cooperating with their sourcing process to incorporate sustainability. Other goal of this research paper is to provide recommendation for sustainable sourcing process for companies and how the stakeholders can be benefitted by sustainable sourcing.

Verma & Ratheesan, (2016) in today's competitive business world, companies should have small lead times, low costs and high customer service levels to survive. Recently low cost countries have huge share in market and they are growing to great extent. To achieve high service levels, companies should make the flow of information, material and resources as efficient as possible. Therefore, it is important to know how a company performs its business and communicates with its suppliers and customers. Having a good relationship with one's supplier and customer is a key success factor in today's business world. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste. To accomplish this, lean thinking changes the focus of management from optimizing separate technologies, assets, and vertical departments to optimizing the flow of products and services that flow horizontally across technologies, assets, and departments to customers. Eliminating waste instead of at isolated points, creates processes that need less human effort, less space, less capital, and less time to make products and services at far less costs and with much fewer defects, compared with traditional business systems. Companies are able to respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times. Also, information management becomes much simpler and more accurate.

Gopinath, Ramanathan & Sankar, (2016) research paper gives an insight about the supply chain issues occurring in medium scale enterprises (MSE). The medium scale industries are the intermediate industries between small scale industries and tier-1 companies. Their role is most important by managing small scale industry suppliers without compromising quality and also satisfying tier-1 companies to sustain in the present vibrant market. In this context the conceptual model is designed considering supplier issues, production issues, financial issues, logistics issues and human resource issues as independent variables and financial performance, technical performance as dependent variable. The supply chain management (SCM) and supply chain risk management (SCRM) are partially practiced without a dedicated team of employees. The authors of this paper are suggesting practicing SCM and SCRM from the beginning of the product life cycle and are suggesting as moderating variables. This conceptual model is validated based on the responses obtained from top officials of three auto component manufacturing medium scale industry (MSE) located near Chennai.

Y. Lee & Rim, (2016) currently, the intensity of enterprise competition has increased as a result of a greater diversity of customer needs as well as the persistence of a long-term recession. The results of competition are becoming severe enough to determine the survival of company. To survive global competition, each firm must focus on achieving innovation excellence and operational excellence as core competency for sustainable competitive advantage. Supply chain management is now regarded as one of the most effective innovation initiatives to achieve operational excellence, and its importance has become ever more apparent. However, few companies effectively manage their supply chains, and the greatest difficulty is in achieving supply chain visibility. Many companies still suffer from a lack of visibility, and in spite of extensive research and the availability of modern technologies, the concepts and quantification methods to increase supply chain visibility are still ambiguous. Based on the extant researches in supply chain visibility, this study proposes an extended visibility concept focusing on a process capability perspective and suggests a more quantitative model using Z score in Six Sigma methodology to evaluate and improve the level of supply chain visibility.

M. Khan, (2016) this research I have tried to focus in Garment sewing plan, proper implementation of plan & its execution by various techniques with IT solution. The best way to cope up the present manufacturing challenges in RMG sewing are the implementation of lean manufacturing,5 S,6

Sigma with effective garment manufacturing software like Fast React & Real-time data tracking and production management systems. This will serve our purpose of flexibility and save a lot of money by reducing production lead time, reducing the inventory, increasing productivity, training operators for multiple works, and by reducing rework.

Haan & Sacristán-Díaz, (2016) Supply chains lack their own across-the-board managers that can design and implement a performance measurement system (PMS), nor do they have an explicit overall strategy from which the PMS can be derived. The focus of this article is to develop a qualitative theoretical model on PM in supply chains to explore how to adopt PMS as a tool to implement col- elaboration and integration in chains. The exploratory nature of the research question de- ermined our use of a multiple case study. Two focal firms in the agro-food sector from Spain and the Netherlands, serving a total of five different chains, illustrate the message of the model. The findings show when an attempt to implement a PMS at the supply chain level might be appropriate and effective (if a chain exists and has a director), and how the system's con- tent should be focused on what is needed to improve chain performance (with end customer's demands as a starting point). The paper highlights the benefits obtained by the other partners if they comply with the best informed supply chain member in the development of the chain's PMS, as well as how a PMS cannot be developed when none of the partners can be labelled as chain director.

Hossain & Roy, The aim of this paper is to identify the impact of Supply Chain Management (SCM) for sustainable growth in Readymade Garments (RMG) sector of Bangladesh. The export-oriented RMG sector has some distinctive features, which differentiate it from other businesses. Wage, supply chain, timeframe, and compliances are among the most important features of this business. Whatever the wage level or lead time is without proper supply chain management no business is viable. RMG manufacturing is one of the suitable examples of the supply chain management. Data for this study is mainly collected from secondary sources. The study reveals that the decision makers and planners of RMG should align their supply chain strategies, work together with all the supply chain partners, share information among the stages of supply chain, have a standard SCM procedure, comply the code of conduct, adapt changing technologies, minimize corruption and bureaucratic tangles in customs, cut lead time etc. to sustain its growth. The most important limitation of this paper was to use data from secondary sources that might limit the generalizability of the results.

Li, Souza, & Goh, (2016) Competition is becoming more global and is between the networks of businesses rather than be- tween the firms. Operating in such an increasing networked environment, companies have to in- novate their business, either be orchestrators or be orchestrated. This exploratory paper propos- as an overarching Supply Chain Orchestration (SCO) framework which leverages on the capabilities of the MNC's networks and the local Logistics Service Providers (LSPs) at a strategic level. This framework comprises integrated components including orchestrated Supply Chain Network (SCN), the relationship model of the actors, a "Win-for-All" pro-orchestration model, and the collaboration platform for the LSPs. Specifically, the paper proposes a practical approach for upgrading the local industry through a virtuous model whereby the MNCs, LSPs, and government agencies collaborate to create a pro-orchestration environment for greater value adding. Using a semi-structured interview approach, key players across the logistics sector in Singapore were interviewed. The approach strategies for realizing this orchestration are investigated and the implications are discussed through a few application scenarios.

Kumar, Amorim, & Arijit, (2016) examine the role of entrepreneurial business models in the reverse supply chain of apparel/fashion retailers. The paper offers an alternative approach to the "return to the point of origin" prevalent in the reverse chain of manufacturers but less technically and economically feasible in the case of apparel/fashion retailers. This approach, second-life retailing, not only reduces waste but also democratizes consumption. Design/methodology/approach – The paper is based on an extensive literature review, semi-structured interviews with managers of two second-life retailers in Malaysia and observations of a number of stores. Findings – Using the Business Model Canvas we demonstrate the essential characteristics of second-life retailers. Retailers in our study, unlike retailers in the developed world, combine traditional business models with off-price retailing. There is no clear demarcation between the forward and reverse supply chain used to manage first- and second-hand retailing.

Law, (2016) developing countries in South and South East Asia are becoming more and more important in the global textile and clothing trade. This can be seen from the fact that South and South East Asian countries' textile and clothing exports to the United States of America have increased in recent years. Some Asia countries include India, Indonesia, Bangladesh, Thailand and Philippines were in the top ten positions of the US clothing importers in 2005. Scholars looking at

Asian countries note that they possess plentiful human resources, rapid development in information, communication, knowledge and talent and rapid economic growth. It is not difficult to understand that Asia is becoming an important battlefield for global businesses. With all the potential advantages Asia provides, apparel sourcing will continue to grow in Asia. Customers now have better choices because the gap between supply and demand has decreased and competition has increased. Customers have begun demanding more features and better service. Because of the need to meet rising demand for consumer products, the productivity of an enterprise is no doubt an important performance measure. Good supply chain performance in manufacturing companies is important for achieving competitive advantage. Logistics plays an important strategic role in the supply chain. Logistics management has developed rapidly in recent decades as an essential business management strategy. It is imperative for businesses to develop performance measurement systems in logistics that provide feedback for timely responses, as well as monitoring and enhancement. This research explores Vendor Logistics Performance and develops a performance measurement tool – the VLPM tool for logistics management to enable Asia's apparel industry to sustain and enhance organizations' competitive advantages. A case study research methodology was adopted to address each of the research questions

Şen, (2008) Fashion industry has short product life cycles, tremendous product variety, volatile and unpredictable demand, and long and inflexible supply processes. These characteristics, a complex supply chain and wide availability of data make the industry a suitable avenue for efficient supply chain management practices. The industry has also been in a transition over the last 20 years: significant consolidation in retail, majority of apparel manufacturing operations moving overseas, and more recently, increasing use of electronic commerce in retail and wholesale trade. This paper aims to review the current state of operations and recent trends across the fashion supply chain in the U.S. We use industry wide data, articles from business journals, industry reviews, and extensive interviews with an apparel manufacturer in California, and a major U.S. department store chain to describe the current operational practices and how the industry is restructuring itself during the transition, focusing at the apparel manufacture and retail segments of the supply chain.

Turker & Altuntas, (2014) in recent decades, the fast fashion industry has been characterized by widespread operations across both developing and developed countries. Due to the economic,

social and environmental problems in developing countries, companies increasingly focus on sustainability and try to ensure the same quality and standards in working and production conditions throughout their supply chains. Although the tension in the exchange of resources between developing and developed countries lies at the heart of current sustainability activities, what these companies are actually doing to manage their supply chain has not yet been explored in depth in the literature. Drawing on the theoretical framework of Searing and Müller (2008), the current study attempts to fill this void by conceptually mapping the current situation of sustainable supply chain management (SSCM) in the fast fashion industry by analyzing reports from 9 com ponies that use the same reporting guidelines. The results of the study reveal that these companies focus significantly on supplier compliance with their code of conduct, employing further monitoring and auditing activities to prevent production problems in developing countries, improve overall supply chain performance and set sustainability criteria for their suppliers.

Hwang & Seruga, (2011) the recent challenge in textile supply chain management is the development of collaboration network which accommodates diverse concerns of various participants while explicitly recognizing interdependencies and promoting effective relationship management. This study is designed to suggest a collaboration network model for textile industry and apply it to establish a desirable framework for the textile supply chain management. The collaboration network model, proposed in this study, is designed to facilitate positive collaboration from the supply chain of the textile industry. Utilizing the collaboration model, an intelligent textile supply chain management system is designed to improve customer services and delivery time, and to promote information sharing, and shorten product life cycle time. The primary goal of an intelligent textile supply chain management system is to promote corporate innovation and information sharing, and generate infrastructure which reduces the gap of the competitiveness across the textile supply chain and enhance the collaboration, which in turn improve the competitiveness of the textile industry as a whole.

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3.1. Doing research in a scientific way

Research is a systematic inquiry process that is used to interpret or discover the facts in an area of interest. The main objective if research is to understand the theories or events or behavior, or to justify the applicability of theories in the practical field. The objective of a business research is to gather the knowledge that assists in business decision making. The validity and reliability of a business research would be questionable if it is not scientific. It is important to know about science before explaining how a research could be scientific. According to the Princeton University Thesaurus (2004), *"science is a domain of knowledge accumulated by systematic study and organized by general principals".* Kerlinger (1973) thinks, science is a method of collecting information on a particular subject or activities and to obtain knowledge from it. Kerlinger, F.N. (1969) defines scientific research as – *"Scientific research is systematic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relations among natural phenomena"* (Kerlinger, F.N., 1969, p. 13).

### 3.1.1. Scientific approach

There are two basic ways for the creation of knowledge in accordance with the philosophy of science- the positivist approach and the hermeneutic approach. Scientific methods of creating the knowledge are based on either of these approaches. The concept "positivism" refers to the knowledge that is extracted from the observable data available in the reality (Alvesson, 1994 in Behumi, V., Holten, C., 2004). Positivists assume the truth as knowledge, rely on the findings of experimental facts and their relations. They also reject human ability to know what is absolute (Mårtensson & Nilstun, 1988 in Mihalache, S., Vukman, P., 2005) and denies the influence of society, culture or interaction with human cognition on truth. By the use of quantitative methods, it seeks to discover the laws (Silverman, 1993). This approach helps to assume that there is objective truth in the world. In order to reveal that truth, positivism puts an emphasis on the measurement of relationships between events or variables and this measurement is done in a systematic and statistical way. Moreover, positivism relies on prediction, observation, explanation

and the test of hypothesis. Under this approach knowledge is developed through induction and hypothesis are developed and tested scientifically. As more and more facts are developed and gathered, they are used to develop explanatory theories (Rapoport 1997). Hermeneutic approach involves both analysis of existing theories and experiential knowledge. According to Crotty 1998, scholars started to use hermeneutics method of research by the interpretation of Bible. Hermeneutics is the *"study of understanding"* (Powell, 1999) or the *"art of interpretation"* (Inwood, 1998) which assumes that meanings are neither fixed nor rigid to any specific point, but gradually changes or develops as researchers come across different situations or perspectives to interpret it (Snodgrass, A. and Coyne, R., 1997). Unlike positivism, hermeneutic approach considers the importance of history and culture and believes that better understanding could be reached as *"historically and culturally located beings"* (Rundell in Crotty, 1991). Hermeneutics is concerned to qualitative analysis of situations and events through the interpretation of texts, questionnaire or interview responses etc. to develop a better understanding of certain phenomenon of interest (Behumi, V., Holten , C., 2004). It emphasizes constructivist approaches, which means that there is no clear-cut objectivity or reality (Cassell & Symon, 1994). Our research is based on case study. We have also used a few theories and concepts to clear the knowledge, on which our findings will be interpreted. Our study involves a qualitative research. So we think that, hermeneutic approach of knowledge development best fits to our study.

### 3.2. Research Design

A research design can be defined as the framework or structure of a research. Providing the consistency, a good research design holds the research project on the right track. In order to find answers to research questions, it determines and explains the method of collecting and analyzing the data. The topic or nature of a research study determines to a significant extent how the research will be designed. We would like to put forward a short discussion on different types of research designs before explaining our research design.

**Research Problem**

**How to minimizing the Lead Time with given order cycle (optimum time duration)**
**In the Sri Lanka modern apparel sector.**

**Research Objectives**

- To analyze the SCM in the textile and apparel sector and assess the current SCM in terms of total lead time in the apparel sector.

- To explore the backward and forward linkages and integrated relationship among the supply chain parties.

- To explore the potentials of SCM and to build a new effective supply chain for CMT (Cut Make Trim) based apparel sector for minimizing lead time in the face of new global apparel.

## 3.3. Research Method

### 3.3.1. Qualitative Vs Quantitative Research

A research can be either qualitative or quantitative in nature. The difference between these two methods lies in the area of

*"subjectivity, a holistic view, a concern about validity, the analysis being close to the data gathered, the process being given great importance, the use of practical case studies, a uniqueness of the study, and interests in specific individuals"* (Bergström, 1994 in Behumi, V., Holten, C., 2004).

Usually qualitative methods are used when it is not meaningful to express the collected data in numbers. On the other hand, a quantitative method is used to analyze the statistical data (Bryman, 2001). Casual relationships are investigated by the quantitative researches between the events, whereas qualitative researches are aimed at interpreting events. The researcher may also be emotionally involved in a qualitative research (http://www.gifted.uconn.edu). According to Ghauri et. al. 1995 some characteristics of a qualitative research in comparison of quantitative research are:

- Rather than testing and verification, qualitative researches emphasis on understanding.

- Qualitative researches focus on understanding from respondent's point of view.

- Qualitative approach is based on rational interpretation rather than any critical or logical approach.

- In qualitative research "observations and measurements are done in natural settings", whereas controlled measurements are used in quantitative research.

- Qualitative method is concerned to closeness to data and subjective "insider view".
- Qualitative method usually does not include any hypothetical tests as it is an "explorative orientation method".

- Qualitative method is process oriented and has a holistic perspective, whereas quantitative method is result oriented and is an analytical method.

- In qualitative research, generalization is made by comparison of properties and considering the contexts of individual organism.

In fact, to conduct a case study there is no hard and fast rule to follow any particular method (Merriam, 1994 in Brask, C., Jonsson, T., 2002) but choosing a method depends on the nature of problem, and the way data and findings are analyzed and generalized (Behumi, V., Holten, C., 2004). We have analyzed and interpreted our findings of investigation rationally in contrast with the understanding we developed in our frame of reference. In this report, we have tried to sketch a total picture of the problem and its implication through logical generalization and for doing this, we have chosen qualitative method. Because we believe that, qualitative method is more consistent with our study. Here it may be noted that, logical or rational analysis means *"analyzing evidence, using formal logic to deduce conclusions from assumptions"* (http://www.daviddfriedman.com). In other words, rational analysis is based on and guided by *intellect* or formal logic and is *"distinguished from experience or emotion"* of individuals (http://www.thefreedictionary.com). For the sake of *rationality* we have utilized our common sense and logic in analyzing the findings to draw conclusion and tried always to be free from emotional biasness.

### 3.3.2. How the research is concluded: Induction Vs Deduction

The research findings can be generalized through induction or deduction, or by the combination of both (Hackley, 2003). General rules or theories are developed from a 21 particular observation in an inductive research. Researchers‟ approach is to summarize their findings from reality in a specific theory through induction. Thus induction moves to specific fact from the general assumption. To draw generalized conclusions out of a single case is the aim of an inductive research. On the other hand, the aim of a deductive study is to draw conclusions on a single, specific phenomenon by using existing general theories. Researchers formulate hypotheses in deductive studies that are examined by empirical data and then verify the accuracy of a theory. It does not matter that, the hypotheses are rejected or confirmed by the theory because, and the theory can be revised according to the need (Bryman, 2001). We have used deductive approach to conclude our findings. Because we have used theoretical concepts to discuss our case and we compared our empirical findings with the theories to confirm the acceptance level of research results.

## 3.4. Sources of Data

There are mainly two types of data based on the sources of availability – primary and secondary. Primary data are first hand data. They are the outcomes of interviews, questionnaire, emails, phone calls etc. (Gibaldi, 1999). On the other hand, secondary data collected, stored and used before (Zikmund, 2000) and available in books, articles, journals, other printed materials, internet and so on. We have used both kinds on data in our study. As a lot of work has been done before on supply chain efficiency or performance and the RMG (readymade garment) industry in Sri Lanka & Bangladesh, we were able to collect some data from secondary sources. Rest of the case specific data were collected as primary data through questionnaires, emails and telephone calls.

## 3.5. Selection of Data

### 3.5.1. Selection of Literature

To make a clear understanding about supply chain management and outsourcing, we have gathered a number of definitions together based on importance and relevance to our research topic. Based on the books, articles, journals and internet resources, we discussed about the concept of outsourcing and supply chain management, their operational process, structure, drivers, motives, contribution to the global economy etc. that can provide a clear concept about our research topic. We also pointed out the factors in light of literature influencing global supply chain efficiency that relates our study with the research topic.

## 3.6 Questionnaire Design

Quotation should be meaningful to the different respondents, it should be simple and understandable. It should be ensured that, the respondents are qualified enough to answer the questions (Berdie, 1986). We prepared different questions for buyer and suppliers. The questions were prepared and answers were expected in such a way that can solve our research questions. We asked and include those questions in our questionnaire, whose answers are not available in secondary sources. Questions were arranged in different headings and mostly in unstructured manner. This is why; there was freedom for the respondents to answer the questions at their own convenience.

Questionnaire was developed with the aid of total 25 literature reviews (Table: 02). The main purpose of this questionnaire was to identify prominent lead time criteria while gather information regarding apparel industry current lead time process & used the 10 literature reviews. The analysis methods that are expected use are Pareto analysis and descriptive analysis. The main question in this questionnaire was ranked response question which is intended to analyze using Pareto analysis. In that question, pre identified supplier selection criteria using literature reviews were expected to rank and identify other criteria that the companies consider in their supplier selection process. The table illustrates the pre identified criteria using past research papers.

(Table: 02) Literature review summery

| **Author** | **Issue** | **Solutions / Findings** |
|---|---|---|
| | | |
| K.Lee | Contribution of SC Technology | Competitive advantage new business |
| Hassan | in Malaysian Textile and Apparel | oppournities SC optimal the benefits. |
| | Industry | |
| | | Motioning operational efficiency get long |
| | | term benefits. |
| | | |
| | | SC technology adoption lead to better |
| | | SC reliability, Increase SC responsiveness |
| | | Improve SC agility, Minimize the SC cost |
| | | and enhance asset management |
| | | |
| | | |
| | | |
| H.Samil | Effective of SCM with Reference to | Trying to the service of 3rd party technology |
| S.Ramakrishnan | Apparels industry in India | providers in order to transit SC information |
| | | via electronic data |
| | | |
| | | Prevent the accumulation of problem SCM |
| | | implementation, should design performance |
| | | assessment program and monitor the |
| | | outcome of these system. |
| | | |
| | | SCM decision should not focus latest |
| | | technology or system rather should consider |
| | | if the resources are available and accessible |

| | | |
|---|---|---|
| | | to them effective implementation SCM |
| | | |
| | | Wasteful plan ineffective design impractical |
| | | essential that the requirement for effective |
| | | SCM implantation |
| | | |
| | | |
| R.Khan | Incorporating sustainability on global | Statistical analysis clarifies more specific which |
| | sourcing process Apparels / Textile, | factors play vital role for incorporating |
| | Garment sector | sustainability and have brought the hypothesis |
| | | result |
| | | |
| | | All the three aspects of SSCM adapting are |
| | | more challenging and most of the company lack |
| | | of sustainable purchasing training and |
| | | understanding. |
| | | |
| | | |
| | | |
| | | |
| | | Top management has less role but sourcing |
| | | strategy is most important for the economic |
| | | sustainability organizational goal. |
| | | |
| | | Supplier / Buyers collaboration important to |
| | | establish social sustainability and economic |
| | | sustainability |
| | | |

| | | |
|---|---|---|
| M.Hassian | SCM for sustainable RMG growth in | SCM process in RMG legging behind in global |
| J.Roy | Bangladesh. | apparel industry |
| | (RMG = Ready Made Garment) | |
| | | Requirements to get better the factory working |
| | | environment, social matters (Wall mat ahead |
| | | SCM generation) |
| | | |
| | | Product / Market diversification advancement |
| | | products desires to be address with extra ordinary |
| | | head SCM scatted. |
| | | |
| | | Direct marketing elimination of middle man can |
| | | help establish an effective SC system. |
| | | |
| | | Political, unrest destabilizing the SCM |
| | | customer issue, performance based SCM not |
| | | possible. |
| | | |
| | | Lacking of understanding SCM in this industry |
| | | management. |
| | | |
| | | |
| Z, Li R, Souza | SC orchestration leveraging on MNC | Create vale through customer center and |
| M.Goh | net works and local resources | integration |
| | | |
| | | Light ownership of assets for orchestrators |
| | | |

| | | |
|---|---|---|
| | | SC Segmentation firms should forces on core |
| | | competence to maintain competitive advantage |
| | | |
| | | Reliability and sustainability |
| | | |
| | | |
| V.Kumar | Second life retiling a reverse SC | Alternative approaches to reverse SCM |
| M.Amorsm | perspective | within the retail sector |
| U.Arjjit | | |
| | | The apparel off-price is impacted on by the |
| | | reverse logistics process where they would |
| | | expected to double the most efficient returns |
| | | process |
| | | |
| | | Alternative business model serves the dual |
| | | purpose of business and envoi mental |
| | | sustainability by avoiding the generation of |
| | | large amount of waste in landfill cites and |
| | | maximizing efficiency by enhancing the value |
| | | proposition. |
| | | |
| | | |
| L.Law | An Expiratory study of vender | Use VLPM (Vender logistic performance |
| | logistics performance measurement for | management) to prevent customers penalties |
| | logistic management in Asia apparels | |
| | industry | Numerous criteria found to be used in VLPM |
| | | |
| | | |

| | | |
|---|---|---|
| D.Turker | Sustainability SCM in the fast fashion | SSCM is a core activity for almost all companies |
| C.Althntas | industry | |
| | | The positioning of SSCM within the report is |
| | | also an indicator of the priority give to the issue |
| | | |
| | | The number of globally dispersed supplier |
| | | varies base on the size of companies the most |
| | | important suppliers are in developing countries |
| | | most in Asia. |
| | | |
| | | Due to the dad reputation of working conditions |
| | | in developing countries and the positive environmental |
| | | impact of proximity sourcing. |
| | | |
| | | Working with European suppliers can become |
| | | a distinguishing features within a company |
| | | SSCM approach. |
| | | |
| | | |
| A.Sen | The US fashion industry ; | Electronic Commerce, B2C, B2B |
| | A Supply Chain Review | |
| | | Retailers continue to source more and more of their |
| | | merchandise from overseas with the cost of having to |
| | | make risky inventory decisions. |
| | | |
| | | Advances in information technology helped companies |

| | | |
|---|---|---|
| | | to gather the customers demand information, And, it will |
| | | help to analytical pricing solutions. |
| | | |
| | | Multi-Item nature of pricing decision in apparel industry. |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| A.Haque | Is Bangladeshi RMG sector fit in | Today companies trying to gain a competitive edge and |
| R.Azad | global apparel business ? Analyses the | improve profitability through cutting cost, increasing |
| | supply chain management | quality an improving delivery. |
| | | |
| | | Order lead time, how can reduce the lead time by an |
| | | appropriate SCM. |
| | | |
| | | Order lead time is the main factors behind the |
| | | lead time problem in the RMG in BD, We can reduce |
| | | maximum 30 days taking proper step in SCM |
| | | |
| | | To reduce lead time effectively we have to reduce |
| | | import dependency as soon as possible, Immediately |
| | | we can reduse30-40% lead time only by proper and |
| | | efficient SCM |

| | | |
|---|---|---|
| | | |
| | | |
| | | |

### 3.7 Validity and Reliability

Numerous evaluation criteria are used to justify the validity and reliability of researches based on the field of research but the credibility can be justified by the readers. The outcome of research is significantly depends on researcher's background when the research is a scientific approach to the knowledge creation. Moreover, it needs a critical approach of researchers that, how they use the theories and empirical findings to analyze and interpret them for drawing a meaningful conclusion.

### 3.8 Validity

There are two types of validity in a research – internal validity and external validity. Internal validity requires a research to be conducted according to the rules and conditions of a standard research. It also includes researchers‟ level of understanding to analyze and interpret the study findings in a sensible way. On the other hand, external validity refers that, the findings of research can be generalized in other situations (Bryman 2001).

To establish the validity in this research, empirical findings have been compared to the similar data in secondary sources. Even, to avoid the misinterpretation, the information of one secondary source was compared to those of other sources. To maintain the validity of the answers of our questionnaires, we scrutinized the responses very carefully. In addition, we discussed with the respondents over telephone to clarify the topic and questions. After receiving the answers from both of the respondents (buyer and suppliers), we recorded the findings as our requirements and send back to them for verification and correction. In this way, finally we used the verified data in our thesis.

### 3.9 Reliability

Reliability indicates the degree of dependability on research findings. It also implies that, if the research is conducted again, the research result will be more or less same (Bryman, 2001). We were very conscious about the matter of reliability during the selection of theories, case company and respondents. The questions included in our questionnaires and respondents‟ answers were relevant to our purpose and research questions. To maintain the reliability, our survey findings were analyzed and interpreted logically and sent back to the respondents for checking the distortion. In a word, all the data were collected and presented here very carefully to make this thesis reliable.

### 3.10 Data Collection, Sampling, Analysis Method

Data collection process was developed in three stages with the intention of achieving two research objectives while investigating the research problem. As the first stage, criteria identification was done with the aid of literature surveys. Then the second stage was consisted questionnaire survey and personnel interviews as primary data collection tools. As the third stage, in order to validate the developed supplier selection model personal interview was conducted to collect primary data.

A proper population had to be chosen where the outcomes of the research will be applicable to that population. Afterwards a sample had to be chosen to reflect the selected population. The results acquired from this sample will represent the whole population and so the results will be generalized to match the population. The population of this research is the companies in apparel industry.
The research can be considered as mixed method of quantitative and qualitative research because situation of Sri Lankan apparel industry lead time process was described while developing a modal to make the process less time and money consuming and make the process effective and efficient manner.

## 3.11 Selection of population and sample

### 3.11.1 Population

An industry which has different lead time base was selected as the population for the study since this study is to identify prominent criteria in lead time and develop a decision support model. Basically target the apparel industry in Sri Lanka specially focusing on large and medium scale companies which are registered under Export Development Board, Sri Lanka. The name list of the population is attached in Annex 3. Although there are 80 companies listed in Sri Lanka Export Development Board, 15 company emails were not valid. So the population size was reduced to 65 companies.

### 3.11.2 Sample

At the first stage, online questionnaire form was developed and sent it to 200 population. For the first questionnaire form, all the companies in population was considered and 40 responses were selected as the sample which was mentioned as there are different lead time. Production professionals, executives and merchandizers were the respondents for the online survey. For the second stage, 6 professionals were selected as the easiness and considering time constraint for the pair wise comparison of prominent criteria. The reason behind selecting 6 professionals was convenience in data collection and analyzing because in this stage, it is expected to use AHP method and it is difficult to work with large number of data in this stage. In order to stimulate the model, one case study was conducted for one company in apparel industry in Sri Lanka. There are different data collection methods with the different level of data accuracy, quality, way of gathering, confidentiality and the response time. In order to achieve research objectives while solving the research problem, both primary and secondary data were collected.

## 3.12 Primary data sources

As the primary data collection methods, questionnaire surveys and interviews were used to facilitate the research. Online questionnaires (developed using the google drive), mailed questionnaires and postal questionnaires were used to collect primary data in order to identify lead

time criteria and descriptive details about the industry. In person and telephone interviews were conducted with the intention of identifying further information and gather primary data to stimulate the model.

The reason for choosing online and mailed questionnaire method is it is the most popular data gathering tool in current context. And also it is easier to reach to the respondents via internet. With the inexpensiveness and time constraint, it is possible to cover wide range of scope via questionnaire and can be easily analyzed using a variety of existing software. But it is important to ensure the accuracy of the data gathered and the in depth details. And this method allows respondents to leisurely fill the questionnaire while clarifying the data with their records. One major drawback of this method is low response rate. With the use of interview method for primary data collection, it is easier to ensure the accuracy of the data gathered while make available interviewer to explain or help clarify questions, increasing the probability of useful responses.

### 3.13 Secondary data sources

Past research papers was helpful to find the lead time criteria within past two decades and the most influential criteria for the process in different international industry setting. In order to develop 1st questionnaire form and selecting the method to calculate the respective weightage for prominent criteria, literature review was the main base. With the time periods, industry evolution and its characteristics, geographical locations and organization culture selection criteria may vary. And also it is useful to refer articles/news related to apparel industry, websites of companies in apparel industry can be treated as important secondary data sources to obtain basic ideas of the industry.

# CHAPTER FOUR: ANALYSIS RESULTS AND FINDINGS

### 4.1 Summary statistics – Descriptive Statistics

Summarize a give date set, which can be either a representation of the entire population or a sample of it. Means that there are in practice/agreed (Table: 03).

(Table 03) Descriptive statistics of CM practices

| | | **SCM Practices** | **Mean** |
|---|---|---|---|
| d | EBSP | Evaluation of buyers (Customers) satisfaction periodically | **4.43** |
| f | HCDBC | Highly concerns to deliver the order on time to keep the buyers' commit | **4.43** |
| r | PCBPSCM | Planning (Source, Make, Deliver and entire supply chain) by collaborating and integrating with internal business processes and supply chain partners | **4.43** |
| kk | PKAE | Practicing Knowledge sharing among employees | **4.39** |
| j | ITATIS | IT applications are used in all transactions and integrated with internal systems **(EDI, EFT, Websites, etc.)* | **4.38** |
| q | MFJSCP | Market forecasting (demand & customer expectation) is carried out jointly with Supply Chain partners *(suppliers, buyers)* | **4.38** |
| s | QNRMHC | Quality and nature of the raw material are highly concerned | **4.38** |
| i | IT APDM | IT applications are used for planning and decision making *(MRP, ERP, VMI, DRP, CRM, etc.) | **4.35** |
| mm | ECSC | Employees in your company are satisfactorily compensated | **4.35** |
| nn | EPACI | Employees have positive attitudes towards changes & innovations | **4.35** |
| b | CKTLPR | Your company keeps trust-worthy, long-term &positive relationship with suppliers & buyers (Customers) | **4.33** |
| k | EBSCMOG | Each business processes in the supply chain matches with the organizational goal attainment | **4.33** |
| l | RFAPTM | Realistic, flexible and adaptable planning (Plan, Source, Make, Deliver, Return ) is highly encouraged by Top Management | **4.33** |
| Collab | COLLAB | Your company collaborative with suppliers when planning (Material Requirement, production, etc.) and new product development | **4.30** |

| | | | |
|---|---|---|---|
| c | CIFP | Buyers' (Customers') inquiries (order processing, complaints & suggestions) are followed up properly | **4.30** |
| z | OTDOFFC | On-Time-Deliver & Order Fulfilment accuracy are measured & improve the efficiency furthermore collaborating with Supply Chain partners | **4.30** |
| ll | PECP | Performance evaluation & revision is conducted periodically | **4.29** |
| Fargee | FARGEE | Formal written agreements are exist with nearly all suppliers | **4.28** |
| t | PDCMS | Product design is highly concerned in manufacturing stage | **4.28** |
| hh | CRCBP | It is highly concerning to reduce Cycle time of each and every business processes (Plan, Source, Make, Deliver, Return) | **4.28** |
| vw | CHPTS | Your company is having proper order tracking system | **4.25** |
| o | PAITP | Proactive actions, changes and innovations are highly encouraged by Top Management | **4.23** |
| x | IRMSCISC | Inventory & replenishment are managed & tracked throughout the entire Supply Chain integrating with Supply Chain partners | **4.23** |
| ii | HCRSCR | It is highly concerning to reduce entire supply chain response time | **4.23** |
| g | OMPP | Order management is practiced properly | **4.20** |
| y | JITMF | JIT activities are synchronized throughout the material flows | **4.20** |
| aa | PMWT | Properly manage the warehouse (raw material & finished goods) & information are integrated throughout the Supply Chain | **4.20** |
| dd | PLWEWM | Production lay-outs have installed to work effectively and to keep wastage at minimal level | **4.20** |
| jj | PPNWE | Proper training is provided depends on the nature of the work of employees | **4.18** |
| h | CISWB | Your company share information with Buyers; ( product availability, cost estimation, customization) | **4.15** |
| m | ALRAESC | Adequate level of resources are allocated for each supply chain processes | **4.15** |
| n | OVWLCC | Your organization values the ideas of workers at every level and necessary communication channels are exists | **4.15** |
| p | TMCCFIC | Top Management highly concerns on cross functional, integration and collaboration among supply chain partners | **4.15** |
| u | LCLMEQ | In logistics, customers lead time, load efficiency and service quality are highly concerned and evaluated | **4.13** |
| ee | WISBS | Work methods, work flow and interface activities with suppliers and buyers are standardized | **4.13** |
| a | CSIS | Your company share information with suppliers (Inventory level, Demand forecasting, product design & quality specification, cost estimation, etc.) | **4.10** |

| | | | |
|---|---|---|---|
| gg | CFMBDCM | Your company rarely faces machinery breakdowns due to having continuous maintenance and upgrading | **4.10** |
| cc | CATQM | Your company always attempt to practice Total Quality Management (TQM) | **4.05** |
| ff | CPUOC | Your company rarely faces the problem of having underutilized capacity or overstretched capacity | **4.05** |
| bb | OPIISC | Operations of production plants are integrated and information are shared throughout the Supply Chain | **3.98** |

## Testing of Sample Adequacy

Sampling adequacy verse tested using KMO & Bartlett's test and the test result shows that the sample adequacy is 0.46 which is marginal but it is significant therefore this sample can be used for analyze the factors.

**KMO and Bartlett's Test**

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .466 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 940.761 |
| | df | 528 |
| | Sig. | .000 |

## Exploratory Factor Analysis (EFA results)

Exploratory factor analysis is a statistical technique that is used to reduce data to a smaller set of summary variables and to explore the underlying theoretical structure of the phenomena. It is used to identify the structure of the relationship between the variable and the respondent.

In order to conduct EFA result we export factor analysis using very muck rotation conversion was conducted and the following are the result.

(Table: 04) Total Variance Explained

**Total Variance Explained**

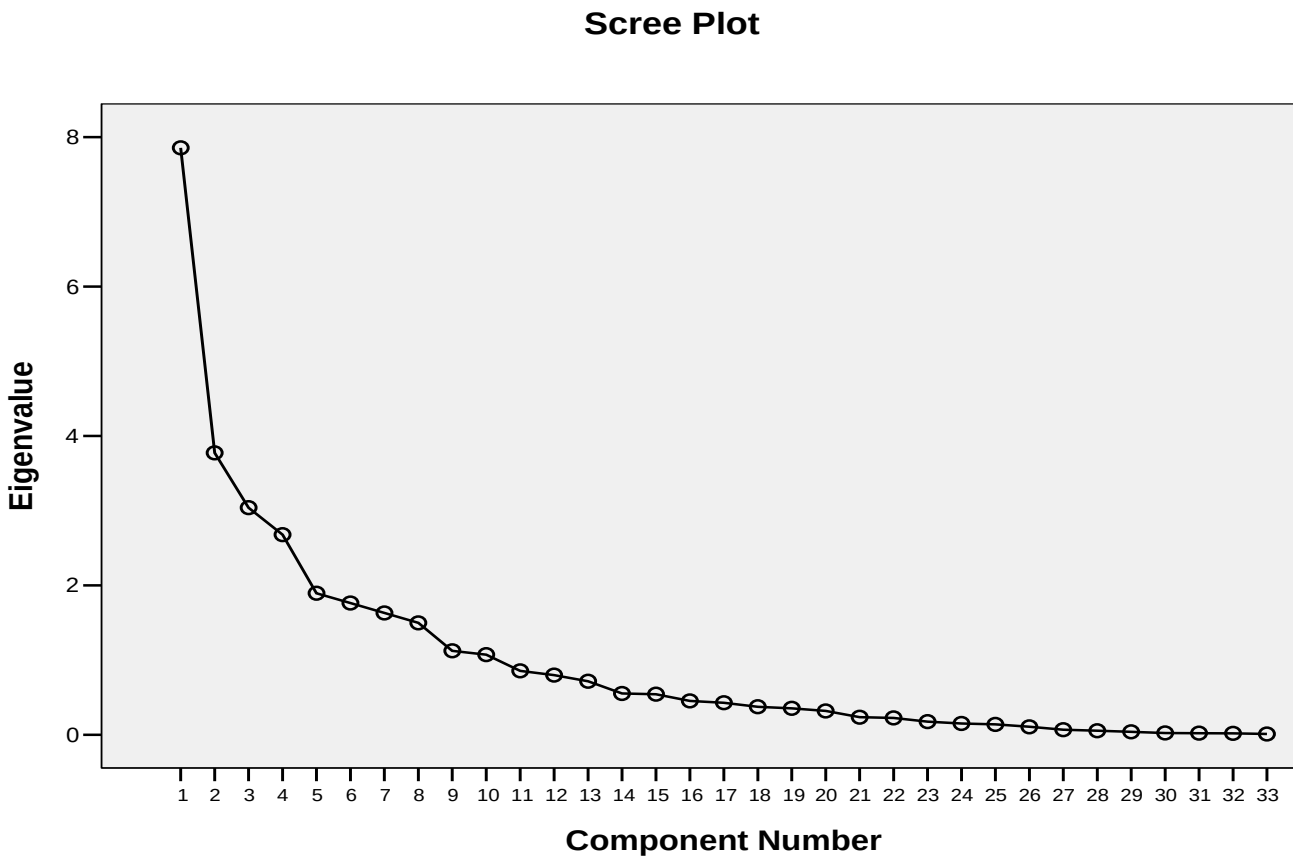
| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 7.857 | 23.809 | 23.809 | 7.857 | 23.809 | 23.809 | 4.165 | 12.620 | 12.620 |
| 2 | 3.773 | 11.434 | 35.243 | 3.773 | 11.434 | 35.243 | 3.399 | 10.301 | 22.921 |
| 3 | 3.040 | 9.212 | 44.455 | 3.040 | 9.212 | 44.455 | 2.871 | 8.700 | 31.621 |
| 4 | 2.679 | 8.117 | 52.572 | 2.679 | 8.117 | 52.572 | 2.693 | 8.161 | 39.782 |
| 5 | 1.895 | 5.743 | 58.315 | 1.895 | 5.743 | 58.315 | 2.621 | 7.944 | 47.726 |
| 6 | 1.763 | 5.344 | 63.659 | 1.763 | 5.344 | 63.659 | 2.587 | 7.838 | 55.564 |
| 7 | 1.631 | 4.942 | 68.601 | 1.631 | 4.942 | 68.601 | 2.410 | 7.302 | 62.866 |
| 8 | 1.498 | 4.541 | 73.142 | 1.498 | 4.541 | 73.142 | 1.950 | 5.908 | 68.774 |
| 9 | 1.124 | 3.405 | 76.547 | 1.124 | 3.405 | 76.547 | 1.823 | 5.523 | 74.297 |
| 10 | 1.072 | 3.249 | **79.796** | 1.072 | 3.249 | 79.796 | 1.815 | 5.499 | 79.796 |
| 11 | .856 | 2.593 | 82.389 | | | | | | |
| 12 | .799 | 2.420 | 84.809 | | | | | | |
| 13 | .717 | 2.172 | 86.981 | | | | | | |
| 14 | .553 | 1.675 | 88.655 | | | | | | |
| 15 | .543 | 1.646 | 90.301 | | | | | | |
| 16 | .453 | 1.373 | 91.674 | | | | | | |
| 17 | .429 | 1.299 | 92.973 | | | | | | |
| 18 | .375 | 1.135 | 94.108 | | | | | | |
| 19 | .355 | 1.075 | 95.183 | | | | | | |
| 20 | .319 | .967 | 96.150 | | | | | | |
| 21 | .235 | .713 | 96.862 | | | | | | |
| 22 | .226 | .685 | 97.547 | | | | | | |
| 23 | .175 | .532 | 98.079 | | | | | | |
| 24 | .151 | .458 | 98.537 | | | | | | |
| 25 | .139 | .422 | 98.959 | | | | | | |
| 26 | .107 | .324 | 99.283 | | | | | | |
| 27 | .068 | .206 | 99.488 | | | | | | |
| 28 | .054 | .164 | 99.652 | | | | | | |
| 29 | .040 | .121 | 99.773 | | | | | | |
| 30 | .024 | .072 | 99.846 | | | | | | |
| 31 | .021 | .064 | 99.910 | | | | | | |
| 32 | .019 | .058 | 99.968 | | | | | | |
| 33 | .011 | .032 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis.

In the total variance explain (Table : 04) the EFA model explain 79% of the variations of those practices variable are explain by the EFA model, Ten factors can be identify among those many variance.

**Scree plot**

Secondly the screen plot also shown that ten variables, after ten it is flat. Then the rotated.



(Table: 05) Rotated component matrix

**Rotated Component Matrix[a]**

| | Component | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SCM Permonce | LT Reductio n | Cost | Quality Improv e | Process Inte | Coll & Plann | Deliv ery Speed | IT | Uncertinit y | Employm ent |
| aa | .842 | | | | | | | | | |
| x | .826 | | | | | | | | | |
| s | .761 | | | | | | | | | |
| cc | .730 | | | | | | | | | |
| z | .727 | | | | | | | .428 | | |
| nn | | .837 | | | | | | | | |
| ll | | .781 | | | | | | | | |
| mm | | .744 | | | | | | | | |
| kk | | .571 | | | | | | | | |
| j | | | .872 | | | | | | | |
| i | | | .663 | | | | | | | |
| k | | | .620 | | | | | | | |
| h | | | .524 | | | | | | | .486 |
| vw | | | | .770 | | | | | | |
| q | | | | .715 | | | | | | |
| u | | | | .622 | | | | | | |
| l | | | | .561 | | .465 | | | | |
| p | | | | | .854 | | | | | |
| o | | | | | .845 | | | | | |
| dd | .494 | | | | .543 | | | | | |
| g | | | | | | .797 | | | | |
| Collab | | | | | | .714 | | | | |
| bb | .442 | | | | | -.629 | | | | |
| hh | | | | | | | .763 | | | |
| jj | | | | | | | .742 | | | |
| ii | | | | | | | .691 | | | |
| gg | | .468 | | | | | .548 | | | |
| m | | | | | | | | .752 | | |
| A | | | .500 | | | | | .657 | | |
| r | | | | | | | | | .765 | |
| y | | | | | | | | | .715 | |
| Fagree | | | | | | | | | | .767 |
| ee | | | | | | | | | | -.755 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 23 iterations.

According to the rotated component matrix (Table: 05) all the ten factors are loaded under different variables.

(Table: 06) Analysis of output result

| **SCM Performance** | | | |
|---|---|---|---|
| | aa | PMWT | Properly manage the warehouse (raw material & finished goods) & information are integrated throughout the Supply Chain |
| | x | IRMSCISC | Inventory & replenishment are managed & tracked throughout the entire Supply Chain integrating with Supply Chain partners |
| | s | QNRMHC | Quality and nature of the raw material are highly concerned |
| | cc | CATQM | Your company always attempt to practice Total Quality Management (TQM) |
| | z | OTDOFFC | On-Time-Deliver & Order Fulfilment accuracy are measured & improve the efficiency furthermore collaborating with Supply Chain partners |
| | | | |
| **LT Reduction** | | | |
| | mm | ECSC | Employees in your company are satisfactorily compensated |
| | nn | EPACI | Employees have positive attitudes towards changes & innovations |
| | kk | PKAE | Practicing Knowledge sharing among employees |
| | ll | PECP | Performance evaluation & revision is conducted periodically |
| | | | |
| **Cost** | | | |
| | j | ITATIS | IT applications are used in all transactions and integrated with internal systems **(EDI, EFT, Websites, etc.)* |
| | i | IT APDM | IT applications are used for planning and decision making *(MRP, ERP, VMI, DRP, CRM, etc.) |
| | k | EBSCMOG | Each business processes in the supply chain matches with the organizational goal attainment |
| | h | CISWB | Your company share information with Buyers; ( product availability, cost estimation, customization) |
| | | | |
| **Quality Improve** | | | |
| | vw | PAITP | Proactive actions, changes and innovations are highly encouraged by Top Management |
| | q | CKTLPR | Your company keeps trust-worthy, long-term &positive relationship with suppliers & buyers (Customers) |
| | u | WISBS | Work methods, work flow and interface activities with suppliers and buyers are standardized |
| | l | COLLAB | Your company collaborative with suppliers when planning (Material Requirement, production, etc.) and new product development |
| | | | |

| | | | |
|---|---|---|---|
| **Process Inte** | | | |
| | p | LCLMEQ | In logistics, customers lead time, load efficiency and service quality are highly concerned and evaluated |
| | o | HCRSCR | It is highly concerning to reduce entire supply chain response time |
| | dd | PPNWE | Proper training is provided depends on the nature of the work of employees |
| | | | |
| **Coll & Plann** | | | |
| | g | JITMF | JIT activities are synchronized throughout the material flows |
| | Collab | CIFP | Buyers' (Customers') inquiries (order processing, complaints & suggestions) are followed up properly |
| | bb | OPIISC | Operations of production plants are integrated and information are shared throughout the Supply Chain |
| | | | |
| **Delivery Speed** | | | |
| | hh | CHPTS | Your company is having proper order tracking system |
| | jj | ALRAESC | Adequate level of resources are allocated for each supply chain processes |
| | ii | OMPP | Order management is practiced properly |
| | gg | CATQM | Your company always attempt to practice Total Quality Management (TQM) |
| | | | |
| **IT** | | | |
| | m | OVWLCC | Your organization values the ideas of workers at every level and necessary communication channels are exists |
| | a | CFMBDCM | Your company share information with suppliers (Inventory level, Demand forecasting, product design & quality specification, cost estimation, etc.) |
| | | | |
| **Uncertinity** | | | |
| | r | MFJSCP | Market forecasting (demand & customer expectation) is carried out jointly with Supply Chain partners *(suppliers, buyers)* |
| | y | PLWEWM | Production lay-outs have installed to work effectively and to keep wastage at minimal level |
| | | | |
| **Employment** | | | |
| | Fagree | PDCMS | Product design is highly concerned in manufacturing stage |
| | ee | CSIS | Your company share information with suppliers (Inventory level, Demand forecasting, product design & quality specification, cost estimation, etc.) |

## 4.2 Variables of the system dynamics model for Sri Lanka

Experts in the industry, good quality means sophisticated products that are somewhat difficult to sew and conform to buyers' requirements. They also comment that buyers from USA focus more on reducing costs while buyers from Europe emphasize on high quality and fashionable products, but also simultaneously on reasonable costs. As the product life cycles are decreasing continuously, the lead time is also decreasing and putting extra pressure to the Sri Lankan RMG industry. So, RMG manufacturers have to supply high quality products at a reasonably lower cost and shorter lead times than before to attract customers from USA and Europe. Some key variables have been identified from the literature review and opinion of experts in the RMG sector. These variables are classified as results, enablers and inhibitors (Table: 07).

(Table: 07) Definitions of SCM variables

| **Variables** | **Remarks and Meaning** | **Types** | **References** |
|---|---|---|---|
| Supply chain performance/ orders/sales | Includes all variables listed below. Lead time reduction, cost minimization and quality improvements are achieved through all other activities as listed below. | Supply chain performance index | Agarwal & Shankar (2005) |
| Lead time reduction | One of the key order winning criteria from buyers. Lead time is the duration of time from order placement to order shipment date. Lead time reduction signifies agility of the | Result | Towill (1996) |

| | | | |
|---|---|---|---|
| | particular company's supply chain. | | |
| Cost minimization | Another key order winning criteria along with lead time reduction. It can be achieved through lean manufacturing, collaborative planning, and integrated supply chain | Result | Mason-Jones, Naylor & Towill (2000) |
| Quality improvement | Sophisticated products at a reasonably low price. It's very important for EU buyers. | Result | Christopher & Towill (2001) |
| Process integration | Working together with suppliers & buyers, a joint effort to solve problems or develop products or quality or system | Enabler | Christopher (2000) |
| Collaborative planning | Use partners' facilities and opportunities to maximize efficiency, capture market potential | Enabler | Christopher & Towill (2001) |
| Delivery speed | Prepare for short-term and long term changes based on market trends/changes and buyers' expectations | Enabler | Christopher & Towill (2001) |

| | | | |
|---|---|---|---|
| Use of IT | Using software and hardware to share information effectively and to improve quality and production speed | Enabler | Yu *et al,* (2001), Fasanghari *et al.* (2008) |
| Uncertainty | Effect of changing market situations, and supply chain unpredictability, bullwhip effect | Inhibitor | Agarwal & Shankar (2005), Mason-Jones & Towill (2000) |

### 4.3 Components of each variable

A number of factors were identified to represent each enabler, result and inhibitor variable, through a search in the literature including published articles and supply chain management textbooks. After listing these factors, questionnaires were distributed among the respondents of the sampled factories to collect their opinions. Factors associated with each variable have been listed in the (Table: 08).

(Table: 08) Factors associated with the variable under study.

| **Variable** | **Components (associated factors)** |
|---|---|
| Market sensitivity | Starting time of raw material sourcing and procurement. Training managers, technicians, workers in manufacturing ability of sophisticated and fashionable garments. Procuring sophisticated machinery to increase the sewing ability of sophisticated garments and improve quality |
| Delivery speed | Assigning importance/priority for special tasks to meet future requirements of market demand such as training of human resources, usage of IT, working together |

| | |
|---|---|
| | with buyers & suppliers, exchange of necessary information among supply chain partners, enhance collaboration with suppliers and buyers, having stable workforce |
| Process integration | Strategically fixed and fewer numbers of suppliers and buyers. The joint work team with buyers and suppliers to solve problems. Providing feedback information to buyers and suppliers to keep them updated. |
| Collaborative planning | Using centralized collaboration teams among factories or production facilities. Informing suppliers and buyers about changes of product design/specification well in advance so that necessary preparation can be taken to reduce waste. Maintain and share up-to-date production and inventory status with buyers and suppliers |

### 4.4 Techniques of breaking the vicious cycle

This figure explains the broadly prevailing concept in RMG sector. The number of orders or total export increases if the customers become more satisfied. There are three parameters for having satisfied customers or buyers. These parameters are cost, quality and lead time. We name this circle as a 'vicious cycle' for this study and analysis. When customers look for short lead time then garment producers cannot supply in a shorter time instead of a usual long lead time. Garment factories can supply garments with shorter lead time with temporarily increased manpower, sub-contracts with other factories and overtime of working hours which, in turn, adds more production and supply chain costs. Thus, garment producers look for more unit-price from the buyers which lead to loosing of orders or dissatisfied customers. Sometimes, buyers look for improved quality without increased amount of unit-price but

apparel manufacturers cannot supply the improved garments with existing prices. Garments' owners argue that they need to employ more workers in the production processes and quality checking and assurance departments to enhance product qualities than a usual level which, again, adds more costs to the unit-price of the final products. Thus, increased costs cannot attract more buyers and more orders. That's why, we call this is a 'vicious cycle' of the RMG sector. However, this study explores that the vicious cycle is a traditional view of cost, lead time and quality. There are some ways to overcome this vicious cycle with latest supply chain management practices, techniques and tools. Some of these potential ways are discussed in the following sections.

### 4.4.1 Process Integration

As process integration emphasizes building long term relationship with few strategic buyers and suppliers, it increases the trust and ability to work among supply chain partners and facilitates collaborative planning. Some scholars suggest that 100% process integration is not achievable if a focal company does not have few strategic buyers and suppliers. When garment companies have some strategic fixed buyers and suppliers, then they can share important, critical and even secret information among themselves. Supply chain partners can have joint teams to solve problems. If the buyers inform their upcoming fashions and designs and order-quantity well advance of actual order placements then garment factories can adjust their production capacities, sub-contracts, workforce alignment as well as sourcing of fabric and accessories. All these efforts can reduce costs and lead time. Even factories can prepare for production processes and train workers if they are informed about upcoming high quality requirements which will also help to reduce lead time and improve qualities. Katunzi (2011) has explained several benefits for manufacturing firms if supply chain integration is achieved. These benefits are more market-share and increased sales, lower inventory, low cost along the supply chain, shortened order to fulfill cycle time which is actually shorter lead time, asset utilization is increased and cost of capital is decreased, flexibility to meet end customers requirement which helps to achieve agile supply chain, more profitability on assets and sales as well as better forecast. So, process integration among supply chain trading partners can break the vicious cycle and increase competitiveness of the garments manufacturers in the world market. Katunzi (2011) has described some key hindrances that resist supply chain integration among supply chain partners in the upward and downward supply chain links. Katunzi (2011) has termed them as "silo mentality" and "lack of trust" among trading partners and even among departments inside a company. Silo mentality means the tendency to maximize profits of his/her own company or department only which is because of the

failure to visualize the complete picture in the whole supply chain. In other words, it can be said that silo mentality achieves only local optimization rather than achieving globally optimized profits maximization or cost minimization. However, Agarwal and Shankar (2005) have explained that silo mentality and the lack of trust can be minimized through collaborative planning and increased use of IT which encourage more information sharing among downward and upward supply chain partners and joint problem solving.

### 4.4.2 Collaborative Planning

Collaboration among supply chain partners can help to achieve coordination of operations which benefits a lot along the supply chain operations (Chopra *et al.*, pp.509-515, 2011; Genoulaz *et al.*, p.243, 2010). According to Chopra *et al.* (2011), collaboration can reduce the replenishment lead time, manufacturing costs, inventory variability and its cost, transportation cost and increase availability of products. Genoulaz *et al.* (p.243, 2010) suggested that collaborative planning can reduce costs and increase benefits for every partner as well as to minimize risks in the supply chain. Agarwal *et al.* (2005) has explained that collaborative planning can increase trust among partners, improve quality of products, increase accuracy of shared information and can have more satisfied customers in the end. Genoulaz *et al.* (p.243, 2010) has divided collaboration into strategic level and operational level. Strategic level encompasses "where" to establish a factory or production facilities and regional distribution centers as well as make or buy decisions etc. Operational level of collaboration includes "what" and "when" to produce using which raw materials such as fabrics, accessories etc. Genoulaz *et al.* (2010) showed that buyer-vendor collaboration and coordination can achieve excellence in operations. Thus, both the levels of collaborative activities can be feasible for RMG or apparel supply chain. Information sharing about demand and supply changes is a great way to achieve collaboration among business partners and simultaneously lack of information sharing is the major obstacle to collaboration. If demand information is properly shared then bullwhip effect can be constrained to a minimum level. For example, if some buyers from the USA or Europe of any particular factory in Bangladesh keep ordering bigger order sizes for a few seasons and do not inform that this trend is not going to continue for next few years then factory will expand its production facilities and recruit more workforces which will be wrong decision in practice. However, if buyers and factory owner are in a collaborative relationship then buyers will inform the manufacturers about future demand changes, shifting of fashions and product requirements which, in turn, reduce manufacturers' risks and increase profitability. Thus from the reviews of articles, this study argues that having a central team or

department who will share and manage information among factories, departments and buyers and suppliers as well as it is a necessary requirement to achieve collaboration.

Secondly, collaboration is also dependent on what kind of information is shared among trading partners. Information about seasonal demand change and product specification change is a vital point in this process. Li (2011) has divided supply chain collaboration into two types, namely, cooperative and exploitative collaboration. This view is very important in today's business. According to Li (2011), in exploitive collaboration, buyers force the suppliers to collaborate with buyers' requirements due to buyer's size, market share and bargaining power as a whole. Though the exploitive collaboration forces suppliers to deliver with low costs within short lead time, it has a negative side-effect. This relationship does not care of suppliers and it becomes fragile in the long run. However, it has a positive side-effect and it somehow improves supplier's efficiency to reduce costs forcefully. Li (2011) suggested that Wall-mart practices exploitive collaboration with its suppliers.

However, Toyota (Li, 2011) practices cooperative collaboration with its suppliers. This relationship takes care of both parties of the supply chain inter-facing partners. As a result, cooperative collaboration accelerates process and supply chain integrations. In this view of management, buyers do not only look for short term benefits of its own business but also they plan with long term vision for quality, cost, flexibility and continuous improvement in suppliers' capacity keeping pace with the changed situation (Li, 2011). The output motive of cooperative collaboration is long term and continuous. In cooperative collaboration, buyers usually invest in favor of suppliers to enhance their capacity and efficiency while buyers tend to shift their costs on suppliers' shoulders to make quick profit in exploitive collaboration.

### 4.4.3 Use of Information Technology (IT)

Information technology has become a major enabler in any supply chain. IT has a great role in enhancing collaborative planning, accurate, timely and sufficient information sharing, process integration and reducing uncertainty in the supply chain management (Agarwal *et al.*, 2005; Chopra *et al.*, 2011). Two types of ways that IT can improve supply chain performance; 1) making the necessary information available and 2) making the information more visible (Chopra *et al.*, 2011). When the

information is available between business partners then it increases collaboration. And the visibility of information facilitates decision making. Both of these help integration and reduce uncertainty in the supply chain. To capitalize benefits from IT usage, many companies have been using some supply chain planning and ERP software such as SAP, Oracle etc.

IT can be used in many operations along supply chain such as production planning, inventory management, transportation and logistics, pricing analysis and decisions, sourcing raw materials and finished goods. Fasanghari *et al.* (2008) divided the areas of IT uses into five categories. These areas are IT on logistic, operation, customer relationship, purchasing, and vendor relationship management. Due to the limitation of time-frame of the study, we have focused on three aspects, namely, purchasing and vendor relationship, operation, and buyer relationship management. The practical scenario which is summarized through gathered data and their analysis of these sections is presented in the chapter "Survey analysis and findings". Farsanghari *et al.* (2011) were limited to enterprise resource planning and identification technologies such as RFID but this study extends IT up to cutting technologies and marker software including the scope of Farsanghari's (2011) IT definition.

### 4.4.4 Market Sensitivity

Market sensitiveness is also an important enabler in the supply chain. Market sensitiveness (MS) refers to the forecast ability about upcoming changes in terms of demand, supply, raw materials, fashion, and customers' requirement in the market (Christopher, 2000). Thus, MS helps to prepare for future market without depending on reactive feedback from the immediate customer only rather it encourages gathering data on pro-active way. Moreover, MS is one of the corner stones of the agile supply chain (Christopher, 2000). MS can help to increase collaborative planning and quality as well (Agarwal *et al.*, 2005). For example, If RMG manufacturers can foresee that European customers are looking for high quality and fashionable items then they can train up human resources and procure machineries to meet European customers' demand. In the same way, if manufacturers can gauge the cost sensitiveness of US buyers then they look for achieving efficiency over time through the lean supply chain and minimizing costs. There are also changes in the supply of raw materials such as fabric market. For example, India is producing and supplying more fabrics to Sri Lanka than it did in the past decade and many manufacturers are importing fabrics from China and India. However, India might support more on their domestic apparel sector to develop further the industry and it takes long time to import from

China. So, Sri Lanka has to invest in textile and produce fabrics to support its apparel exports. All these proactive decisions come from MS.

### 4.4.5 Delivery Speed

The factories can gauge the future changes in market and adopt action plans accordingly to tackle the predicted changes then delivery speed increases. However, delivery speed not only considers the predicted changes but also tackle the present situation in the marketplace as well (Agarwal *et. al.*, 2005). If a company increases its delivery speed then it works with its suppliers to leverage opportunities and build partner relations (Power *et. al.*, 2001). Thus delivery speed can help to increase process integration and reduce lead time as well as increase collaborative planning (Agarwal *et. al.*, 2005). Factories can increase delivery speed in a number of ways such as reciprocally increased information sharing with suppliers and buyers, training own workforce including production workers, technicians, engineers and managers, installing new and sophisticated machineries to serve the next days' market.

## 4.5 Lead Time

Lead time, like in any other manufacturing fields, is undoubtedly one of the predominant issues in outsourcing and durable global marketing of apparel industry that largely depends on accomplishing an order within a certain elapsed time to meet the customer demands properly. The three parameters cost, quality and lead time for apparel retailers are critical but one can't deny the importance of finishing a job as early as possible since it is perhaps some buyer's requirements. The following list will throw light about the necessity of lead time.

- Product cost, quality and lead-time are correlated. Quality denotes the existence and performance of the product. However, paying high cost to get the product that exceeds the sell period converts to huge loss to the retailer.

- Fast fashion apparel is time sensitive and follow a very tight timeline and meeting the deadline is important than ever.

- Quality and lead-time go hand in hand. High quality products with simple design need shorter turnaround time compared to the embroidered or premiere fashion cuts.

- The time needed for the raw-material like fabric, trims or other accessories is important as that would define the timing of the finished goods. Longer lead times generally tend to stock higher inventory levels for the retailers.

- Lead time reduction can lower a firm's overall costs and make it more responsive to the marketplace by decreasing the amount of finished goods inventory required.

- Lead time data is effectively a measure of the total manufacturing process. It tells how quickly raw materials can be converted into delivered product to the customer. Apparel manufacturing process is made up of many steps. Some of those involve a manufacturing process whilst many are just moving materials or product and waiting for materials or product. Having a high lead time is an indication that the process is not optimized.

However, the lead time in Sri Lankan RMG stands for the duration from order placement date to shipment date to reach at the Colombo sea port. Almost, all respondents in the first survey opined that lead time is the highest critical factor for success and continuous growth of the apparel sector in the upcoming days. Then, this study conducts second survey dedicated to only on lead time issues to identify its obstacles, factors, and ways to minimize lead time. Most manufacturers in Sri Lanka are apprehending that lead time will be a crucial factor to survive in the days ahead. The details about lead time have been stated in a separate chapter. However, to the minimum level of discussion about lead time to form CLD is presented in this section. If lead time is reduced then total costs in the whole supply chain stages can be dramatically reduced as inventory holding time and capital investment are reduced. Reduced lead time can have more satisfied customers and can capture the market trend in time to increase sales (Agarwal *et. al.*, 2005). Moreover the lead time paly major role in the respect of the apparel sector, even if the buyer given the lead time for production process it seems other factors also get it to the consideration for on going further details. Finally, reducing the lead time apparels owners get more benefits mainly higher the profit by giving the incentive to the employee side. And, can be get both end satisfaction.

### 4.6 Cost

Cost is the most important decision variable for US buyers while quality and cost both are the primary decision variables for European buyers. Cost has many components including direct and indirect materials, labor, transportation, inventory, and overhead costs. If minimizing total supply chain cost is the objective then it ultimately increases competitiveness. If any garment factory only looks for minimizing its own manufacturing, fabrics and other costs then the total supply chain cost may not necessarily be reduced. The silo mentality cannot minimize costs across the whole supply chain. The increased cooperation, collaboration, and coordination by developing an integrated supply chain among the upward and downward trading partners which will extend their hands from design and development stages to manufacturing to distribution up to the end customers can minimize the total costs (Chopra *et. al.,* p.48, 2011). To become competitive, total cost view is very important over individual costs in apparel industry. There are some suggested ways to reduce costs like achieving economies of scale through bigger quantities of orders, reducing lead time and having integrated supply chain (Agarwal *et al.,* 2005).

### 4.7 Quality

Quality is one of the three main result variables in our study. There are different kinds of definitions of quality. This study tackles only manufacturing quality since RMG is a manufacturing industry. The ability to meet stated features is often regarded as a quality. For manufacturing products, quality refers without defects, and deviations in required features and measurements (Business Dictionary, 2013). Experts in RMG sector commented that making garments of complex features and designs are termed as high quality products. Producing high quality products, which are free from defects and without significant variations in measurements, is difficult and adds additional costs. Thus, product cost increases for high quality garments. But this study tries to analyze how to reduce costs while making high quality garments by capitalizing the scope within an integrated supply chain.

### 4.8 Uncertainty

Due to the time limitation and difficulties to measure other inhibitors such as lack of trust, this study considers only one inhibitor that is uncertainty. Uncertainty mainly results from demand and supply sides in a supply chain. Demand uncertainty is higher when the product is a fashion item and it has low

product life cycle. Apparel sector includes many fashionable items and these fashions are changing very quickly and, thereby, demand and requirements are changing quickly from year to year in the same market. There are also lots of uncertainties in supply sides of raw material and accessories of apparel industry. Price and quality of materials, political instability, trade barriers between countries and exchange rate fluctuations are major sources of supply uncertainty. In 2010-2011, the prices of cotton and fabrics fluctuated so abruptly in Sri Lanka, Bangladesh and Indian markets that many RMG producers faced very bad situations and could not procure raw materials on time. Having said that uncertainty is an inhibitor, it puts obstacles to perform at their full potential by companies in a supply chain. However, many companies started vertical integration in upward supply chain to minimize supply side uncertainty but, recently, keiretsu in Japan has brought a new type of solution to reduce uncertainty (Bechtel and Handfield, 2002). The more the uncertainty is in a supply chain, the more the bullwhip effect is in demand forecast (Mason-Jones and Twill, 2000). The best solution, to minimize demand and supply uncertainty, is to share more information through using IT and build partnership and trusted relationship among supply chain partners (Bechtel and Handfield, 2002; Mason-Jones and Twill, 2000). Besides the use of IT and information sharing, Christopher and Twill (2001) have suggested "decoupling" of operations to reduce uncertainty in supply chains. Decoupling or postponement of operations is a very useful technique to achieve lea-agile supply chain. Operations achieve lean manufacturing up to decoupling point with large amount of production and quick delivery is possible after de-coupling point with customized features when orders are placed. This technique is widely practiced in the paint distribution system. However, some manufacturers and retailers of clothes and fashions in Bangladesh have been practicing this technique. Manufactures are sewing garments of certain common designs for some common sizes and making particular sizes after consumers buy them. Thus, they reduce total inventory, uncertainty of demand fluctuation and obsolescence risk.

# CHAPTER FIVE: CONCLUSION AND FUTURE RESEARCH DIRECTIONS

## 5.1 Introduction

As the impact of physical boundaries is decreasing with the advent of the latest information and communication technologies, markets are continuously becoming more globalized, and new competitors are progressively entering into the market with newer and more innovative products and services to compete with the existing ones. The apparel industry is highly globalized with a number of key exporters and importers from Asia, Europe and the Americas. Moreover, the product life cycle of apparel products, many of which are fast fashion items, is decreasing quickly. Consequently, the time allowed for design-to-market is decreasing over time which is directly pushing suppliers or manufacturers of garments to reduce the duration of the "order issue date to the shipment date". Garment manufacturers do not deal with the design and the marketing stages, dealing with only "raw materials sourcing to garment manufacturing to shipments at Chittagong port". With the emergence of new competitors, the presence of existing players, and the garment sector no longer enjoying the MFA (Multi-Fiber Arrangement) in the US market since 2005; the garment business is increasingly becoming more and more competitive in terms of quality, cost and lead time. In such a competitive environment, many suppliers from China, Hong Kong, India, Vietnam and Turkey etc. are supplying similar or better quality apparel at a reasonable cost. However, an industry that can supply a reduction in the product life cycle will garner more customers, who are time sensitive, over competitors who are still struggling with lead time. It can be concluded that while several competitors can simultaneously serve higher quality products and at a reasonably low cost, reduced lead time is the last and most important criteria for the industry clientele. So, this study is dedicated to investigating the reasons of long lead time in the supply chain and providing solutions for the Sri Lankan Ready-Made-Garment (RMG) industry. In our investigation, these problems are identified in both the backward and forward supply chain links.

## 5.2 Literature related to lead time

Time has become such a valuable asset that any company that can exploit it can increase its competitiveness to a greater extent than ever before. Timing has become a crucial factor in many aspects of business including but not limited to planning, innovating, manufacturing, selling, distributing, and adopting strategies and policies (Stalk, 1988). Stalk (1988) also suggested that while cost, quality, manufacturability, newness /innovation evolved as a source of competitive advantage, time has positioned itself as the latest weapon to compete in the marketplace. Martin Christopher (p.149, 1998) also asserted that time has become very important to compete against competitors and the main reason for this change is the change of the customers' awareness and preference for time. In the fashion market, new styles are released frequently, lasting for a short period of time, being replaced by new trends. Thus, end consumers are also becoming more conscious about the latest fashion trends in the apparel market. Now, innovative designers around the world are also bringing new designs to the market with an ever increasing frequency. It has been noticed that a new and fantastic style, which conquered the market in one season (summer/winter), will also be replaced the following season. So, it's very difficult to forecast whether the same popular fashion trend will continue into the following season. As a result, seasonal and cyclical demands are fluctuating severely. So, it clearly indicates a shortening of the fashion life cycle in the end consumer market.

Products usually pass through the different stages of the life cycle which requires different planning strategies in order to enhance its success. Each successful product goes through at least the four stages in the product life cycle which are: introduction, growth, maturity and decline. The product life cycle length is also different depending on the product, where the fashion life cycle usually experiences a sharp decline at the end of the growth stage.

## 5.3 Sri Lankan garment industry in the global value chain

The apparel industry is a perfect example of a buyer-driven value chain (Gereffi & Memedovic, 2003) and lead firms who are mainly from the United States, Europe and Japan, dominate the market structure in terms manufacturing location(Fernandez-Stark et al., 2011). They also determine the market prices of apparel products. Fernandez-Stark et al., (2011) classified the global apparel supply chain into five identifiable sectors:

- Raw material supply, including: natural and synthetic fibers
- Provision of components, such as the yarns and fabrics manufactured by textile companies;
- Production networks made up of garment factories, including their domestic and overseas subcontractors
- Export channels established by trade intermediaries
- Marketing networks at the retail level.

Our analysis shows that the industry is partially involved in the second category and fully (100%) involved in the third category to produce garments as per buyers' orders. How this positioning of the industry.

## 5.6 Methodology

Both qualitative and quantitative research strategies were applied to deeply look into the breadth of the research questions and to find their possible solutions. A Quantitative research method was applied for conducting a survey among target respondents in which a well-defined survey questionnaire was used as the research instrument, which was full of close-ended questions. The other set of the questionnaire was distributed among experts which was full of open ended questions. Most merchandisers responded from different factories because they usually deal with lead time including order negotiation and import of necessary raw materials such as fabrics and accessories. Survey questionnaires were developed preceded by a literature research and expert discussion over the phone. The structured questionnaire was composed mostly of "yes/no" and multiple choice questions. The questions for identifying reasons behind long lead time were asked by using a 5-point Likert scale. These questions had the following multiple choice rating scale given by: 1 = strongly disagree, 2 = Disagree, 3 =Neutral, 4 = Agree, 5 =strongly agree.

## 5.7 Variables and their inter-relationships

Here we define, explain, and show the inter-relationships among the different variables. The variables are listed in (Table: 09) including their type and measurement units. The primary strength of the Bangladesh RMG industry is low cost labor availability and good quality in garment sewing. However, respondents of the survey have identified long lead time as the most critical problem to compete against China, India and Sri Lanka. For woven garments, China and India can deliver the products within 50-

60 days and 60-70 days respectively whereas Bangladeshi exporters can deliver within 90-120 days on the average. This long lead time is appearing as a potential threat to the future growth of the apparel industry. The respondents opined that China and India have their own textile factories to produce woven fabrics which have enabled them to deliver within a shorter lead time. Bangladesh textile mills, as the domestic source of woven fabrics, can only supply 40% of the total demand and the other 60% are mostly imported from China, India, Pakistan, Indonesia, Indonesia and Turkey. Contrary to the woven fabrics, Bangladeshi textiles can supply 90% knit fabrics of the total domestic consumption per year. As a result, the knit sector can compete almost equally to the lead time of both China and India. So, this study has identified the lack of woven fabric production in Bangladesh or import from other countries as the major cause of long lead time. It takes about 28 days to import fabrics from overseas countries (count is based on the major source, China). Some experts have suggested that lack of a deep sea port at Chittagong is another determining factor for long time to import as it takes almost one extra week at a Singaporean or Sri-Lankan (Colombo) deep sea port to change ships. At present, only some feeder vessels ply directly from Shanghai to Chittagong, which only covers 10 % of the total shipment of Chittagong Port from China, however, the other 90% of the time, the route through Singapore is employed, where mother vessels unload to feeder vessels. From the analysis of the survey questionnaires, we have identified two main variables that contribute to the major factors of lead time and where policies can possibly be adopted to reduce it. The domestic supply of fabrics and the deep sea port at Chittagong can drastically reduce lead time as well as build a strong and integrated backward supply chain of the RMG industry (Table: 09).

(Table: 09) variable in the lad time management level model.

| **Variable name** | **Type** | **Measurement unit** | |
|---|---|---|---|
| Woven fabric | | Knit fabric | |
| Domestic fabric production | Stock/level | Million meters | Million kgs |
| Total fabric demand | Stock/level | Million meters | Million kgs |
| Growth in fabric production | Auxiliary | million meters/ year | mill kgs/year |

| | | | |
|---|---|---|---|
| annual demand increase in fabric consumption | Auxiliary | million meters/ year | mill kgs/year |
| import requirement | Auxiliary | million meters | mill kilograms |
| production capacity addition | Flow | million meters | mill kilograms |
| percent that can work 60 days | Auxiliary | Dimensionless | Dimensionless |
| import lead time | Auxiliary | Days | Days |
| demand accumulation | Flow | million meters | mill kilograms |
| time reduction factor | Auxiliary | Dimensionless | Dimensionless |
| total lead time reduction | Auxiliary | Days | Days |
| forecast lead time | Auxiliary | Days | Days |
| present lead time | Auxiliary | Days | Days |
| impact of deep sea port | Auxiliary | Days | Days |

## 5: 8 The Agile Supply Chain

In recent years there has been a growing interest in the design and implementation of agile supply chain strategies (Christopher, 2000).The idea of agility in the context of supply chain management focuses around 'responsiveness'. Conventional supply chains have been lengthy with long lead-times and hence, of necessity, have been forecast-driven. By contrast, agile supply chains are shorter and seek to be demand-driven. A further distinction is that because conventional supply chains are forecast-driven that implies that they are inventory-based. Agile supply chains are more likely to be information-based. By their very nature, fashion markets are volatile and difficult to predict. Hence the need for agility. It has been suggested (Harrison, Christopher & van Hoek, 1999) that an agile supply chain has a number of characteristics. Specifically the agile supply chain is:

- Market sensitive – it is closely connected to end-user trends
- Virtual – it relies on shared information across all supply chain partners
- Network-based – it gains flexibility by using the strengths of specialist players
- Process aligned – it has a high degree of process interconnectivity

### 5:9 Market sensitivity

Being close to the customer has always been a goal of any market-oriented business, but in fashion retailing it is vital. Successful fashion retailers capture trends as they emerge using a variety of means. Point-of-sale data is analyzed daily and is used to determine replenishment requirements where the intention is to continue to make the product available. Often though the Agile Supply Chain Network Based Virtual Market Sensitive Process Integration. Selling season is only intended to be short and product will not be replenished, in such situations the data is used to analyses trends. Beyond point-of-sale data are real consumers and identifying their preferences and changing requirements should be a continuing priority. Zara, the Spanish-based fashion retailer, has teams of fashion 'scouts' who seek out new ideas and trends across the markets in which they compete. They also use their own salespeople to identify customers' likes and dislikes and to feed this information back to the design team. Using computer aided design and computer aided manufacturing (CAD/CAM), these ideas can quickly be converted into tangible products and be in the marketplace in a matter of weeks.

### 5:10 Virtual integration

The agile supply chain is virtual in the sense that it is connected and integrated through shared information on real demand so that all the players in the chain, from the fabric manufacturers to the garment makers to the retailer, are all working to the same set of numbers. Retailers and their suppliers need to be more closely connected through shared information than was the case in the past. Until very recently, few retailers in any sector would share point-of-sale data with their suppliers. Now, however, there is a growing realization that shared information can enable higher levels of on-the-shelf availability to be achieved with less inventory. Simultaneously, transaction costs can be reduced particularly if the co-operating parties are prepared to move to co-managed inventory (CMI). CMI is a process through which the supplier collaborates with the retailer to manage the flow of product into the customer's distribution system. The supplier and the customer jointly agree the desired stock levels

that need to be maintained in the retailer's operation. The customer feedback sales data is sent on a regular basis to the supplier who then uses that information to plan replenishments. Typically such arrangements work best where the demand for the product is relatively stable and replenishments within the season are possible.

### 5:11 Network based

A distinguishing feature of agile companies is their use of flexible arrangements with a wide supply base. Zara and Benetton are two fashion companies that have achieved high levels of customer responsiveness by working closely with specialist, often small, manufacturers. The strategy at Zara is that only those operations which enhance cost efficiency through economies of scale are conducted in-house (such as dyeing, cutting, labelling and packaging). All other manufacturing activities, including the labor-intensive finishing stages, are completed by networks of more than 300 small subcontractors, each specializing in one particular part of the production process or garment type. These subcontractors work exclusively for Zara.

### 5:12 Conclusive discussions

The cost, quality and lead time are the most important influencing variables to sell garments to the overseas buyers. While many other competitors from different countries are providing garments with the same quality at reasonably low costs, then reduced lead time becomes the remaining and final criterion to secure sales. Thus, both the sales and supply chain performance can be improved if apparel manufacturing companies can further reduce the lead time. When lead time is reduced, it has a great impact on other key variables such as cost and quality. Not only waste in different processes and departments along the garment supply chain partners can be minimized but also cost may decrease because significantly reduced the inventory cost and capital investment is resulted due to the reduced lead time. As a result, a company can gain more orders from the buyers. The use of information technology (IT) among the supply chain partners and within the planning and operations of internal processes such as pattern making, cutting, sewing and finishing, etc. may to help reduce the lead time. When the use of IT is increased, collaborative planning and process integration also increase. As a result, it helps to reduce uncertainty along the total chain and results in increasing supply chain performance and meeting buyers' order quantities and delivery dates. The survey responses and depth

interviews show that the competitiveness of Bangladesh garment industry is such an important issue that most respondents in the survey ranked it one of top priorities for securing new orders. We also discussed this matter with the experts in the industry. All the respondents agreed that reduction in lead time can help increase industry's competitiveness and sales accordingly. To emphasize on this point, we included a separate section about lead time reduction strategy in the questionnaire to collect suggestions from the respondents. The CLD diagram for all variables and the SD model for reducing lead time will hopefully help to maximize the scope of attaining optimum solutions in the supply chain since they show the interdependence among variables and the dynamic behavior of the variables. The CLD shows a complete or apt picture of how the whole supply chain variables are interlinked and how they can be affected by other variables. A department may obtain its optimum objectives even if sub-optimum solutions are taken by other departments or for the whole supply chain. The system dynamics model can help to achieve local optimum solutions for a global supply chain, through better understanding and policy making. The system dynamics model helps policy makers to understand how to integrate supply chain trading partners in backward and forward linkage to maximize supply chain surplus. Finally, it can help the top management to understand and analyze how the performance variables are inter-related, where to de-couple some performances, and where to emphasize and de-emphasize to achieve the whole supply chain objective.

### 5:13. Limitations of the research and future research directions

There are some other enabler variables such as data accuracy and introduction of new products, and two other inhibitors, namely, a lack of trust and resistance to change (Agarwal et al., 2005) that can greatly affect supply chain performance. These variables are not considered in this research. Customer satisfaction was also excluded from our research although it could be used as a result variable. Though customer satisfaction is the measure of availability of garments to the buyers' location when they are required, measuring this index seems to be very difficult in the case of RMG industry given time frame for this research. Thus customer satisfaction has not been considered in our research. Nowadays, green supply chain management has a significant impact on the sales performance of garments in developed countries. But green supply chain has also not been taken into consideration to develop the causal loop diagram and modeling because its exact impact on supply chain performance was difficult to identify for the time being. Separate researches may be carried out to measure and model customer satisfaction, and green supply chain management in Sri Lanka as further research. We have considered the cost, quality and delivery (CQD) as the order qualifiers; flexibility has not been considered, though it can

have a significant impact on sales or the order winning process. The results of the supply chain models might vary when more variables are included. As for future research, it seems that compliance issues have become a newly emerging vital factor to attract orders from developed countries after some deadly fire accidents, building collapse and some other types of accidents in Sri Lankan factories. So, it should be taken into consideration in the future for the sake of growth of the industry. A few more variables such as the effect of research and development (R&D), domestic cotton production, and supply chain complexity can be invoked to model the performance more accurately. Moreover, new components can be added to the proxy parameters for market sensitiveness and process integration as well as lead time.

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