Faculty of Technology

Lean Practices in Bangladeshi Textile Industry

A Literature Review

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Abstract

Lean manufacturing is a concept of eliminating waste and non-value-added activities or process by using different lean tools or techniques. In developing countries, many organizations are implementing lean production to make a continues improvement in their business process. The aim of this thesis work is to investigate the lean practices and their extent by administrating with several lean manufacturing model case studies in the Bangladeshi textile industries as well as other countries using secondary data and observations. This work discussed the model case industry especially from Bangladesh also India, USA. In the beginning, there has discussed the lean thinking and the origin of lean, principles of lean, different lean tools, the critical success factors and so on. The study shows the potential improvement after lean Implementation by analyzing the production processes of the case industries. The most important findings of this study refer that the selected case industries are implementing a variety of lean tools but mostly in use is Six sigma, Value stream mapping (VSM), 5S, Visual management, Just in time (JIT), Kanban, Kaizen, Poka-yoke, Visual controls and Quality circle to improve their production processes. Also marking out some findings of different kind of benefits that are getting the industries of Bangladesh by implementing lean, some impeding factors, as well as different supporting factors, are also identified.

Keywords: Lean Manufacturing, Value Stream Mapping, Just in Time, Visual Management, Textile Industry.

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It was really a great learning experience during the period of thesis work. I have searched different articles, journals, books, and also trying to get some real learning experience from the practical field throughout my research study.

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Md Saiful Islam

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Abbreviations

GSP	Generalized System of Preferences
TPS	Total Production System
FPS	Ford Production System
JIT	Just in Time
VSM	Value Stream Mapping
VM	Visual Management
TPM	Total Productive Maintenance
CSFs	Critical Success Factors
SMEs	Small and Medium-sized Enterprises
CT	Cycle Time
HR	Human Resource
CEO	Chief Executive Officer
ZQC	Zero Quality Control
IES	Industrial Extension Service
CFO	Chief Financial Officer
SOP	Safe Operating Procedure
BGMEA	Bangladesh Garment Manufacturers and Exporters Association

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1. Introduction

Cost and time associated with manufacture and quality administration or wastages decreases have a vital effect on the total internal economy of the industry. It's important for the management of industry to eliminate non-productive practices and time to keep the industry economy sound. Regarding this matter the management has been taken to explore and apply lean manufacturing in the textile business. Started and developed in Japan, Lean Manufacturing can be deliberated as a business system which attempts to recognize waste and abolish it. In this way, it prompts enhancement in quality and profitability of production and service management in an economical manner over others. Industries in Bangladesh, particularly the textile sector has endeavored to implement this, however, a little research work is done in with respect to its appropriateness. This research will indicate the suitability of lean manufacturing system assisted the textile industries in Bangladesh in relation to other countries. To envisage the distinctive kinds of wastes produced in the industry and future potential outcomes of dumping or lessening them. This research will be administrated with several lean manufacturing model case studies in Bangladeshi textile industries as well as other countries using secondary data and observations. The result of this perception mirrored that industry may increase higher efficiency and benefit by legitimate utilization of lean manufacturing. (Islam et al., 2013).

1.1. Study Background

Readymade garment and textile industries began in the late 1970s, extended vigorously during the 1980s and blasted during the 1990 in Bangladesh. The fast development of the business was possible as a result of the accompanying unique of the business, for example, the less convoluted technology, cheap and effectively working machines and a low cost substantial shabby female workforce. In the worldwide textile business, Bangladesh contributes under 5% which comprise 75% of aggregate export income in Bangladesh. With the closure of tax-free quota and GSP, the trading condition has turned out to be furiously focused, Bangladesh, whose economy is vigorously reliant on its subsector, will currently need to compete against textile bigshots like China and India. (Sultana and Islam, 2013)

Previous external and internal studies recommend eradicating wasteful aspects and anomalies particularly reducing production lead time and wastages from the nation's textile industries and

exporting procedures. In a very competitive business environment, the textile industry has various scopes and opportunities of development utilizing lean manufacturing principles (Mercado, 2007). This is because of the business operation nature of export-based readymade textile industries. The development of profound effectiveness through a decrease in complete 'production and conveyance' time will enhance surface-level effectiveness by lessening lead time. (Sultana and Islam, 2013).

Clothing is a combined word for items worn on the human body. Apparel and garment also have almost similar meaning. Apparel mainly clothes of a particular type when they are being sold in a shop. Garment is also a piece of cloth. Clothing can be produced from textiles, animal skin, or other materials placed together which can be worn. A textile is a flexible material comprising of a network of artificial or natural fibers, artificial fibers like yarn or thread. Yarn is made by spinning raw fibers of cotton, wool, hemp, flax or other materials to produce long strings or strands. Textile industries mainly produced textile and apparel or garment. Some of which produce both. Textiles are produced by weaving, knitting, tatting, knotting, crocheting, braiding or felting.

1.2. Research Objectives and Research Questions

The primary purpose of this research is to analyze the extent of lean manufacturing practices in the Bangladeshi textile industry. Examine how lean manufacturing enhances the production performance and distinguish factors for an empowering environment for implementing lean effectively. This investigation plays out a relative study to analyze the relationship between the aftereffects of the present study with other worldwide examinations looking at comparable methods of insight.

Since developed in Japan lean manufacturing practices are applied in many developing and developed countries. In respect to other countries, Bangladesh is somewhat new in lean practicing countries. Industries with assembling facility and industries that need huge human involvement in manufacturing lean most widely. Generally, the profitability of these industries is highly impacted by the proficiency and attention of the humans who are working physically with machinery or working gear like textile industries. This research means to investigate the adoption of lean practices in the textile industries in Bangladesh and its effect on overall performance. In this view

of the initial interest and issues enduring in Bangladeshi textile industries, primary research questions (RQ) developed are-

RQ1. What are the lean principles and the different lean tools? and how they affect the overall mechanism and productivity of an industry?

The First research question will be answered in the literature review chapter of the article of the study. On the basis of literature review, a conceptual framework of lean manufacturing, different wastes of lean, advantages of lean implementation, critical success factor and a brief description of textile industry will be discussed in this section.

RQ2. What are the lean practices applied in textile industries in Bangladesh for enhancing production performance and how the application carried on?

This research question will be answered in the Case studies and empirical data chapter of the article. This section will provide information available on articles, scientific papers, case studies and other published materials to explain the implementation of lean in textile industries of Bangladesh. This section also enlightens the lean practices, their framework, and effects in India, USA and other countries of the world.

RQ3. What is the extent Bangladesh benefited and results generated from practicing lean in textile industry compared to other countries practicing lean manufacturing?

The third research question will be analyzed and discussed on the basis of gathered data in the data analysis and Discussion chapter. This chapter will focus on comparative study and analysis on the extent of practicing the whole lean system in the textile industries of Bangladesh and the practices globally. That chapter will also convey the findings on benefit generation by the implementation of lean practices to draw the conclusion.

1.3. Research Process

The motivation behind this research is to recognize and assess the research into the relationship between lean, and extent of lean implementation in Bangladesh and sustainability, and to arrange the important articles to find conceivable gaps, issues, and openings for further research. This

article will help in setting up a higher comprehension of lean manufacturing rehearses and the difficulties that industries facing.

To determine research areas which are emerging and need further study to be done in detail, the literature review is an advanced step. (Webster and Watson, 2002). A writing audit distinguishes the applied substance of the field (Meredith, 1993). A literature review helps to develop the theory advancement (Seuring and Müller, 2008) and can contribute to finding the theoretical content of the research area (Meredith, 1993).

Internet and Databases are the most economical and compelling way to bring out research. This internet or web for learning clarified as giving access to the main reference databases covering a huge number of journals, books around the world, and additionally conference proceedings. Nonetheless, there is such a great proliferation of data – both convenient and non-convenient, genuine and dubious, dependable and undependable, and above all useful and worthless. So, after selecting research quest related keywords we have to search precisely in sources that show authentic results like Google Scholar and other renowned journals like Emerald, Springer, Taylor & Francis, IEEE and Elsevier publishers for beginning the quest for quality research papers.

The following figure 1 represents the outline of the research process. Chapter one elucidates the brief outline of the research that includes research background. It also provides validation of the selection of the research area and explains the objectives of research and gives the research structure.

Chapter two consists of a literature review. That contains definitions of mandatory terms used in research, existing theoretical models and frameworks. Research and analysis strategy used previously in this research area, philosophy and studies of other authors that has common research quest are also introduced in this chapter.

Chapter three constitutes the methodology of the work. This chapter describes the process on which the research will carry on. This chapter also explains the research design, data collection method, consideration of data collection and the research philosophy.

Chapter four addresses the case studies and Empirical data collection processes and its presentation, secondary data collection, observations, case studies are facilitated and presented in this chapter through charts, figures, and elaborate explanations.

Chapter five accounts for data analysis and discussions. This chapter has a responsible role for core research goal achievement. Data analysis compares the research data with the previous study from the literature review. Research questions and objectives will be discussed precisely in this chapter.

Chapter six concludes the thesis. This chapter summarizes the extent of attainment of research goal and objectives. It will also enlighten the opportunity of further research in this area and also concede the limitations of the study.

Figure 1. Research structure outline.

2. Literature Review

2.1. Lean Thinking and Management

Lean production involves multifarious combination of thoughts including unceasing developments, compressed organization framework, collaboration, proficient assets, cooperative supply chain management and eradication of surplus or waste. (Green, 2000).

Lean production was first introduced and got its name from a 1990's best seller The Machine That Changed the World: The Story of Lean Production (James P. Womack, et al, 1991). This book records the development from small craft production of automobile fabrication to large scale manufacturing to lean production. It recounts the narrative of how Henry Ford institutionalized vehicle parts and assemble procedures, with the goal that low skilled laborers and particular machines could make inexpensive automobiles for the majority. The book proceeds to portray how large-scale manufacturing gave less expensive automobiles than the craft production, however, came about an issue of planning, engineering and management. At that point the book clarifies how a small industry set its sights set on assembling vehicles for Japan, however it couldn't bear the huge investment need in single purpose machines that appeared to be essential. Nor might it be able to bear the indirect labor and inventory appeared to be essential for large scale manufacturing. So, it developed a superior method to get things done, utilizing low inventory and moving basic leadership to production workers. Now the small production units developed into a huge organization, and the Toyota Production System has turned out to be known as 'lean production'.

2.1.1. Origin of Lean thinking

The Japanese have been utilizing this idea to decrease the expense of any procedure, can be in production unit or service industry by expelling waste. The essential components of the idea incorporate waste elimination, consistent single work process (EPA, 2003). Lean generation envelops the entire assembling series from product strategy to product improvement and even clinches supply (Cooney, 2002). Lean alludes to efficiently distinguishing and disposing of waste through persistent enhancement utilizing the pull production so as to get impeccability (Kilpatrick, 2003).

The lead time between a client demand and the shipment of the items of demand by disposal of all types of waste in the production process is being reduced by lean. Basically, lean standards and techniques emphasizes on making a consistent development of culture that connects with workers in decreasing the intensity of time, resources and investment important for fulfilling client's need (EPA, 2003). This operational system focuses to accomplish the most brief conceivable process duration by taking out waste. This procedure means to grow the effectiveness included work by decreasing inadvertent work. This system is utilized to build productivity by decreasing expense and by understanding the significance of worth to the client since esteem is the real determinants of lean production. Organizations are presently persuaded about the advantages of lean, and they are utilizing this procedure in both generation and service industries.

Indeed, production strategy even only 10 years prior this was seen as an irrational option in contrast to conventional production models (Hayes, 1981). Yet, it is the archetype for activities and its impact can be found in a wide scope of assembling and service methods (Katayama and Benett, 1996; Womack and Jones, 1994). Advantages of lean production are apparent in processing plants all over the world and organizations report decreases in process duration, enhanced quality of product, decreased work in progress, enhanced time conveyances, reduced costs, enhanced overall gain, enhanced usage of labor, decrease in inventories, faster profit for stock venture, more elevated amounts of production, enhanced adaptability, higher space use, decrease in device speculation, more work concentration, a superior use of tools, and better abilities improvement" (Pavnaskar et al., 2003).

Lean Production is a theoretical structure dependent on a couple of standards and systems (Sanchez and Perez, 2001) as delineated in Figure 2. The Figure demonstrates the factors that support to accomplish production goal and the delivery of the product just in time. These factors have effect on just in time (JIT) manufacturing and conveyance in proper scheduled time. This in a coordinated way drives organization to accomplishing competitiveness. As expressed before, lean production focuses primarily around non-stop flow of production. This implies the ideal batch size is unlike the conventional production condition where batch size determined on individual manufacturing procedure. Continuous flow requires work-cells that are composed of products instead of process (Mercado, 2007). This move requires very controlled procedures worked in a well maintained, arranged and clean functioning setting that consolidates standards of just in time manufacturing

and employee included, framework inclusive, constant improvement (EPA, 2003). Appropriately, lean production itself incorporates five center ideas (Womack and Jones, 1994).

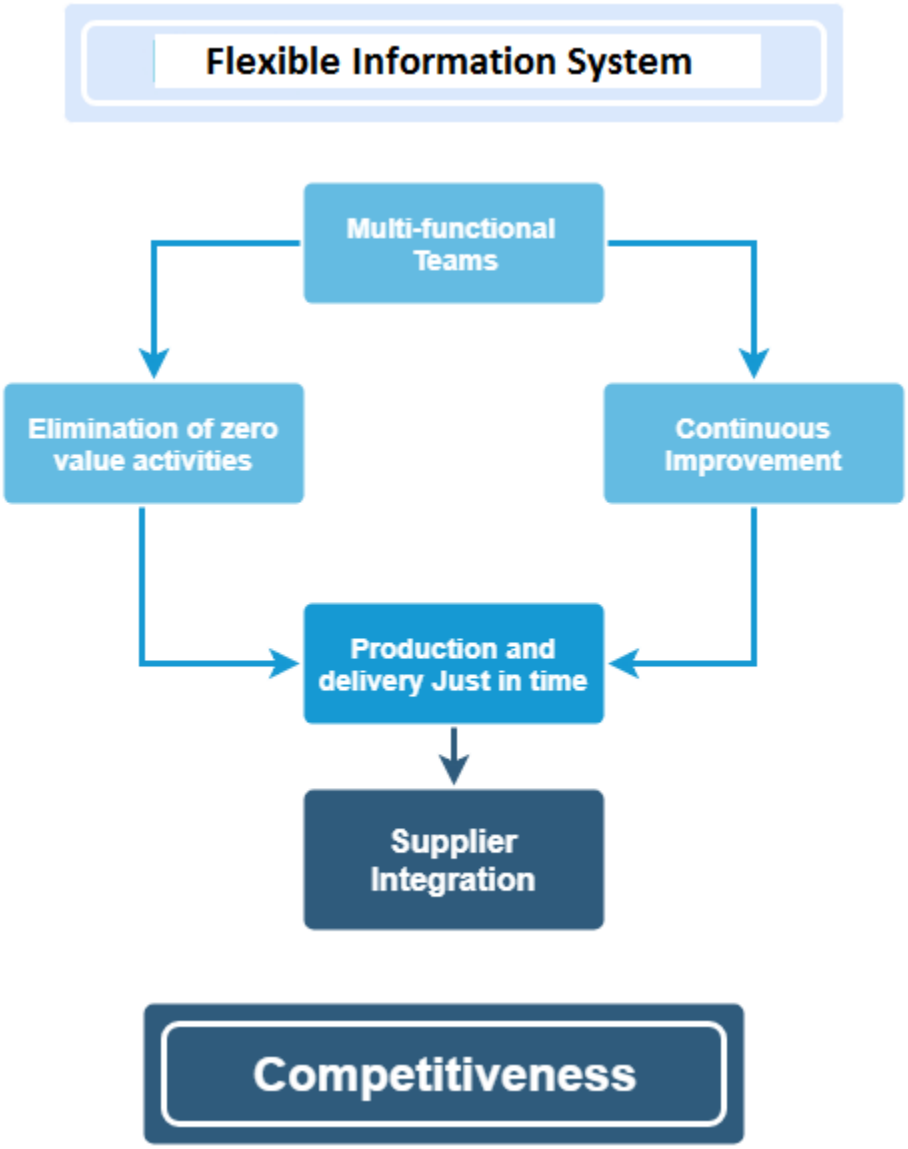

Figure 2. A Lean Production Model (Modified from Sanchez and Perez, 2001)

2.1.2. Toyota Production System (TPS)

As already introduced, the idea of lean production was officially first presented in Toyota (Sohal and Egglestone, 1994). This framework was prominently known as Toyota Production System. This is a production system which includes exercises that augment an incentive by lessening all types of waste. The vice president of Toyota Taichii Ohno, was the driver behind the making of

the Toyota Production System is called the father of Toyota Production System (Sohal and Eggelestone, 1994). Production under this system categorized as adding value or reducing waste. Toyota Production System has emphasized to a difficult issue of defining the value and came up with an elegant solution.

The aggressive market competition forced by large scale manufacturing frameworks throughout and after the World War II period drove the Toyota Motor Company to an intensive investigation of the production assembly line of the American motor industry and specifically for the Ford Production System (FPS) (Papadopoulou and Ozbayrak, 2005). The arrangement offered by Toyota prompted a total recreation of the organization and they built up a substitute manufacturing framework alluded as the TPS, which went for straightforwardly assaulting any type of waste in the manufacturing procedure (Ohno, 1988). In 1949, EiJi Toyota visited the world's biggest vehicle maker Ford and understood that, there was an excessive amount of waste all over the place (Dahlgaard and Dahlgaard Park, 2006). There were waste in the form of labor, energy, materials, time and space, that is muda of transport, muda of labor, muda of inventories and abundance handling, muda of imperfections, muda of facilities, muda of waiting " (Dahlgaard and Dahlgaard Park, 2006). Propelled by the waste removal ideas industrialized by Henry Ford in the beginning of 1900s, Toyota made a hierarchical culture concentrated on the efficient recognizable identification and end of all lavishes from the manufacturing procedure" (EPA, 2003). This development established at Toyota has been utilized in numerous different organizations and businesses. Toyota's market administration in the business might be, to a substantial degree, ascribed to its capacity to address the expanding difficulties for survival through lean manufacturing framework. It should be noticed that lean manufacturing, established by Toyota, includes stock and quality control, business relations, employee administration and provider-producers' relations (Wu, 2003). Toyota Production System emphasizes the decrease and removal of waste inside the manufacturing plant surroundings (Ohno, 1988). TPS incorporates 5S, suggestion intake, imperfection cautioning, total precautionary support, visual monitoring and standard activities. Toyota got in an experimental year more than 700,000 improvement proposals from the workers from all levels of which in excess of 99 percent were executed and therefore, the organization accomplished unparalleled worldwide intensity to compete (Liker, 2004; Phan and Matsui, 2007; Ohno, 1988). Toyota's achievement in the lean execution infused many different organizations over many different industries to reproduce progressive production techniques of

Toyota to address their maneuvers (EPA, 2003). Liker (2004) depicts in his book that the administration standards of Toyota and states Toyota is the most noteworthy producer in the world.

2.1.3. The Five Lean Principles

Industries, can be service or production, should concentrate on ceaseless development by utilizing the five standard Lean principles to improve their activities (Loughrin, 2010). Womack and Jones (1996), (Bicheno, 2004) first depicted these principles. The principles are postulated for example, the value, the esteem flow, value stream, pull and perfection by Melton (2005), which are depicted as follows:

The first is determining the value from perspective of client. Production based organizations are possibly going to offer products which are advantageous for makers, instead of concentrating on manufacturing items that clients will value (Womack and Jones, 1996, Bicheno, 2004 and Melton, 2005). In this way, they are confronted to create item portfolio reliant on understanding clients' necessities that prompts to meet Lean principle to postulate values (Melton, 2005).

The value stream is the second one, which implies arranging forms from resources to definite client dependent on the perspective of clients, instead of what production units need (Womack and Jones, 1996, Bicheno, 2004 and Melton, 2005).

The third guideline or principle is tied in with production of value stream that has pursue with processes, individuals and culture (Melton, 2005), also it is utilized to lessen postponements of significant value-added practices and dispose of non-value-added exercises.

The fourth principle is use pull, implies that removal of superfluous manufacture by concentrating on the requirements of clients (Loughrin, 2010).

The number five guideline is pursuing flawlessness. Flawlessness or perfection includes improving quality, just as manufacturing what clients need, just-in-time, with a sensible cost and with zero waste (Womack and Jones, 1996, Bicheno, 2004). This implies development cycle ought to be consistent and it should never be terminated (Melton, 2005).

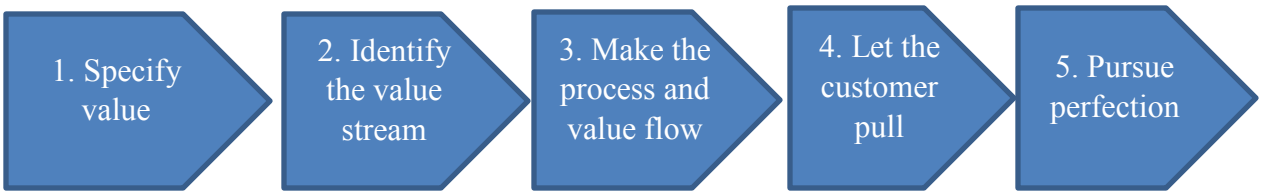

Figure 3. The Five Principles of Lean (Modified from Westwood et al., 2007)

These are the five standards initially created in assembling, yet they can similarly be implied in service industry. Figure 3 demonstrates the five standards. The most significant one is the second principle, which underlines distinguishing proof of the procedure that makes an incentive for client that can be accomplished through the value stream in manufacturing or production-based industries. Rest of the principles in service industries are correspondent to as in production-based sectors (Westwood et al., 2007).

2.1.4. Lean Thinking

The basic goal of Lean production is to possess a ceaseless development framework, which works on removal of wastes at a minimal point and to ensure that all practices and procedures that happen in any unit of the organization enhances esteem to the immediate customer. Change of resources and data into products as well as services to fulfill the clients' requirements and orders are categorized as value-added services (Modi and Thakkar, 2014). Processes that devour materials regarding resources and additionally human practices, though don't add any value to the fulfillment of client's need are altogether considered as wastes (Wahab, et al., 2013). Lean is persistently linked with Wastes.

The Japanese word for waste is 'Muda'. In search of getting result for waste-driven methodology, seven wastes are distinguished by Taiichi Ohno that harrow the continuous flow of practices and activities that adds value to the clients need (Bucourt, et al., 2011). Other authors added underutilized individuals to the original list of seven wastes distinguished by Taiichi Ohno. Then again, a similar sort of waste has been named as "unused employee creativity" (Wahab, et al., 2013). Numerous author and researchers have contemplated and consented to the eight wastes type depicted below.

2.1.5. The Seven wastes of Lean

Overproduction

Excess of production prompts wastes, happens when continual production of services and products are made too quickly which results in overproduction. This kind of waste is made with the "just-in-case" mindset rather than "just-in-time" while production (Wahab, et al., 2013). This sort of waste can produce if management choose to yield just a lot of required, the produced duplicates that won't be used by any individual from the organization to profit the client winds up waste and in the long run prompts expenses and increment in undesirable stock. Ohno has distinguished waste of overproduction as the most important wastes amid the others as it is the beginning of problems inside the organization (Wahab, et al., 2013).

Waiting

At the point when the time isn't utilized successfully, it prompts misuse of time and waiting. An excess of holding up intrudes on the continuity of production and management, which is one of the key basic principles of Lean reasoning. Waste of waiting incorporates when a machine breakdown that requires a specialist technician to fix before work can be in advancement when it comes to a point of taking a decision. Intemperate waiting time has been recognized as the component that adds to higher lead times, incapable consumer loyalty and competitiveness (Wahab, et al., 2013).

Waste of Motion

Waste in motion or mobility has both the component of human and machine in it. The human components of waste in motion happen because of worker's efficiency in their working environment or ergonomics. Appalling office design that leads workers in difficulties reaching documents or things that are put away a long way from them when it tends to be effectively located close to them, needless movement, and work rotations that leaves the worker stressed (Wahab, et al., 2013). Wellbeing, efficiency just as eminence of work is profoundly influenced by poor ergonomics of the work environment (Dennis, 2007).

Waste of Transportation

The transportation of resources or products from place to place that does not enhance the value of product to the final client is considered as waste. Which could be as resource, products or actual clients. For example, moving and passing clients between offices, from desks to desks and from one work area to the next to finish a procedure is classified as waste transportation (Kavanagh and Krings, 2011).

Waste by Inventory

Irrelevant and avoidable stocks like raw materials, resources, work-in-progress and or completed products are causes waste, which are categorized as waste of inventory (Dennis, 2007). Incongruous retention of stock winds up waste when it thwarts the consistent flow of work, takes more space that could influence contact and connection between work place, expands lead time expected to serve clients, and avert fast detection of products when required that wastes time (Wahab, et al., 2013).

Waste of Process

Inability to convey clients' prerequisites to employees, poor communication with clients and lack of understanding of client's requirement, and the failure to produce what clients requires into real items. For example, this kind of waste occurs when reports are overproduced which is excessively long and intricate (Kavanagh and Krings, 2011).

Waste of Defects

When defects are produced resources, time, cash and vitality is damaged and wasted each time this kind of waste occurs. Re-production makes the worker do what has just been done erroneously. Re-manufacturing results in twofold costs and time, unsatisfied clients and some of the time absolute loss of clients. In 2013 reviewed more than 1.6 million automobiles had to recall by Toyota, which had faulty airbags from the manufacturing. This costs them a great deal and to some degree the organization's fame (Kavanagh and Krings, 2011).

Figure 4. MUDA -Seven types of wastes (Modified from Modi & Thakkar, 2014)

2.1.6. Lean Tools and Techniques

Lean Six Sigma

Six Sigma (6σ) quality is a system for problem solving which was first utilized at Motorola to signify its methodology for the most reduced conceivable futile. Six sigma speaks to the numerical count, 99.9996% flawlessness which is extremely near zero imperfections. Lean Six Sigma consolidates Six Sigma approach with lean production devices. Lean six sigma is an information

driven way to deal with discover the underlying causes of issues, the executives system to oversee lean tasks to economic goals, and utilizations the DMAIC (which is define, measure, analyze, improve, maintain) procedure to sort out working procedures (Taghizadegan, 2006).

Value Stream Mapping

For practically all organizations, value stream upgrades are a basic advance to getting to be lean; the plan of the total value stream must be considered as opposed to applying devices arbitrarily, or to address a clear issue (Womack and Jones, 1996). Value Stream Mapping (VSM) is utilized broadly in Six Sigma Methodology and has lately been added to the instruments which can be utilized to apply the standards of lean (Henderson and Larco, 1999). Value stream maps contrast from procedure stream maps in that VSM maps contain all the value included and non-value included exercises, incorporate the data stream alongside the material stream to make the item, are a shut circuit from the client back to the client, and contain no takt time is considered in procedure stream maps. VS maps ought to be made of the present condition of the assembling procedure to make a specific product offering or family, all the data ought to be accumulated at one time as the guide will speak to this specific time and date.

After the present state has been finished and percent value included, the handling time that the client is eager to pay for, can be determined as the proportion of the complete lead time to value included preparing time. From the present state, issues in the process are recognized and objectives for development are distinguished and put on the future state map. Value stream maps transfer data, for example, machine use and stock in each procedure and their impact on the general lead time of the item, which takes into account prioritization of ventures which would have the best impact on the general lead time. Value Stream Maps can be utilized so as to imagine and make enhancements for a procedure; this is done through a future state guide of the procedure, which speaks to the perfect circumstance of the procedure.

Visual Management

The objective of visual management is to make a workplace self-clarifying, self-ordering, and self-improving (Grief, 1995). In his book "The Visual Factory" Grief shows this thought in a visual management triangle found in Figure 5 below. In this kind of working environment, workers can promptly see out of standard circumstances and effectively take remedial activities.

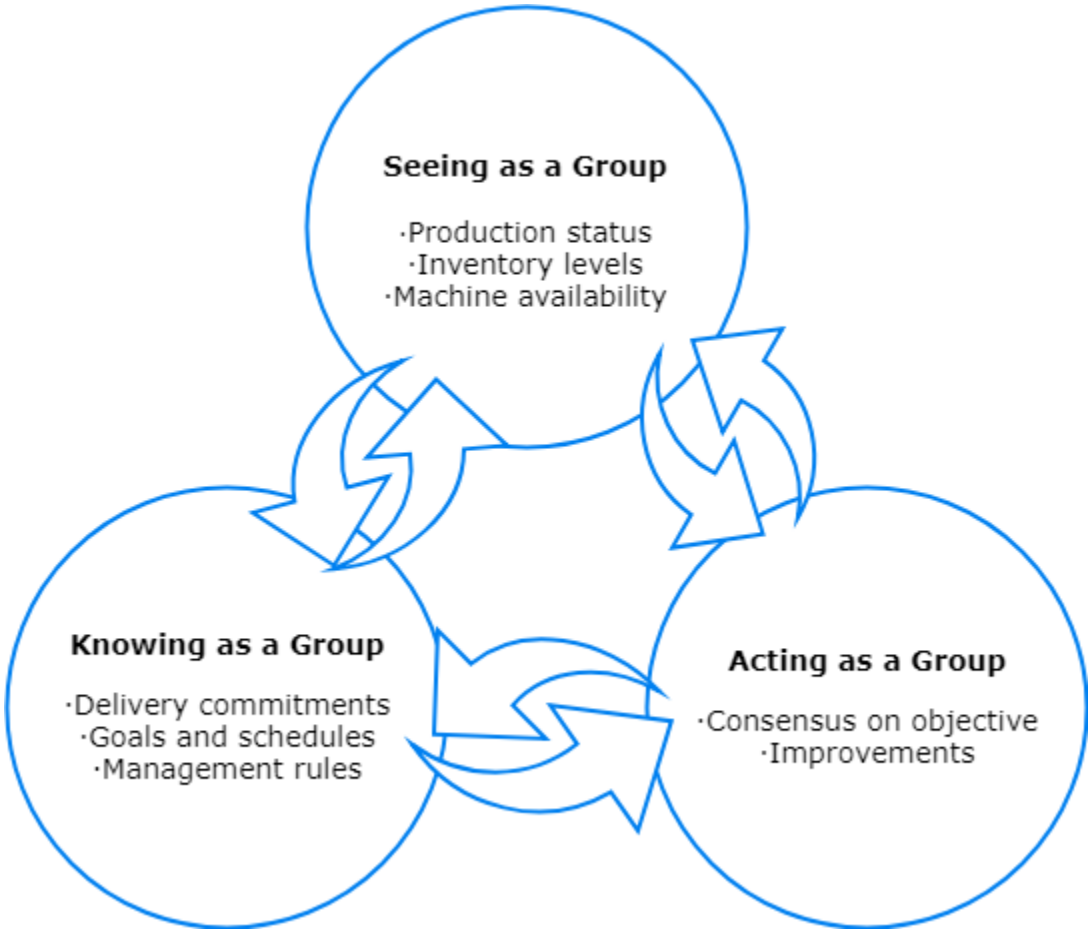

Figure 5. The Visual Management Triangle (Modified from Grief, M. 1995)

The 5S System

The 5s system is a framework which support to arrange any kind of business or task, and 5s constitutes of five stages including: sort, set in arrangement of order or spot, shine, systemize and sustain (Hirano, 1996). Every one of these means must be pursued to have accomplishment with a 5s occasion or for a task to state that they are 5s. Though the second and third step, set in

arrangement and shine, might be exchanged among them relying upon the requirements of the organization utilizing 5s.

Total Productive Maintenance

Total Productive Maintenance (TPM) is one more segment of visual management, which works particularly well with the 5s authoritative framework. As talked about before, one mainstay of 5s is shine in which cleaning is utilized as a type of assessment. The objective of this is to in the long run train the administrators to care for the gear in their workstation (Nakajimi, 1988). TPM doles out essential upkeep work, for example assessment, cleaning, greasing up, fixing, etc. to the employees. This releases up the specialists or support group for other productive maintenance, which incorporates higher value adding exercises, for example, gear and machine improvement and updates, training, and so on. Similarly, as in for safety the objective is zero rates, in TPM the objective is zero breakdowns (Nakajimi, 1988). The key proportion of TPM is machine efficiency, which is accessibility, execution proficiency, and Overall Equipment Effectiveness (OEE).

Kaizen

The term kaizen is frequently referenced in the utilization of lean production system. It just signifies, "change for the good of all", in Japanese and is utilized as an enhancement technique. Kaizen is the beginning stage for every lean activity. Kaizen is a group way to deal with rapidly tear down and reconstruct a procedure format to work the more proficiently (Ortiz, 2006). Quality in Toyota's JIT production framework depended on the kaizen constant improvement idea. This methodology is utilized to make a trial and error system in the reduction of waste and streamlining procedures. This methodology is rehashed again and again to consistently search for issues and solution arrangements (Russell and Taylor, 2002).

Poka-Yoke

Standardization, visual management, and 5s are lean devices, which can be utilized to improve human liability. Poka-yoke is another technique for this reason. Poka implies coincidental error and yoke implies counteractive action to resolve the error. Poka-yoke is actualizing basic minimal

effort error proofing framework that recognizes anomalous circumstances before they happen or once they happen, stop generation to avert defects (Shingo, 1985). Poka-yoke decreases the physical and mental pressure of always checking for normal mistakes that lead to deformities, for example missing procedure steps, process mistakes, missing work procedure, absent or mistaken parts, ill-advised gear set ups, etc. A decent poka-yoke must be basic and low maintenance, entirely dependable, minimal effort, and intended for the particular working environment condition. At the point when a poka-yoke distinguishes a blunder, it ought to either shutdown manufacturing or conveys a notice of warning. Cautioning poka-yokes ought to be utilized if the ceasing of the line amid the center of a procedure builds the potential for deformities. A viable poka-yoke must review 100 percent of the things and give prompt feedback for countermeasures (Shingo, 1985).

Takt Time and Cycle Time

Takt time or process duration is the time expected to produce one unit of an item to client order, estimated as the passed time between the finishing of one unit and the completion of the following (Monden, 1993). The word is of German origin and depicts a clock interval. The takt time uncovers the interest recurrence or how often an item should be delivered, takt time is determined as pursues:

$$\text{Takt Time} = \frac{Daily\ Operating\ Time}{Daily\ Amount\ of\ the\ Product\ Required\ by\ Customer}.$$

Just-in-Time Production

Just-in-time (JIT) generation implies delivering the correct thing, at the opportune time and in the correct amount. JIT comprises of numerous other lean tools, for example, kanban, heijunka (manufacture leveling), SMED or fast machine changeovers, visual administration and having a steady procedure which is of advantage as various lean instruments for example, 5s, TPM, and standardized work (Monden, 1993).

Kanban

Kanban is the Japanese word for card or correspondence. A kanban is a noteworthy segment of Just-In-Time production. Three kinds of kanbans are predominantly utilized: withdrawal Kanban,

production order Kanban, and provider Kanban. A withdrawal Kanban indicates the sort and amount of an item in which the ensuing procedure ought to pull back from the first procedure. A production order Kanban, occasionally called brought in-procedure or production Kanban, indicates the type and amount of an item in which the first procedure must deliver. A provider Kanban or subcontractor Kanban is utilized for making withdrawals from a seller like a parts or materials provider. The provider Kanban incorporates directions, which demand the conveyance of the provider is item (Monden, 1993). Following figure gives a visual delineation of the Kanban pull framework (Vatalaro and Taylor, 2003).

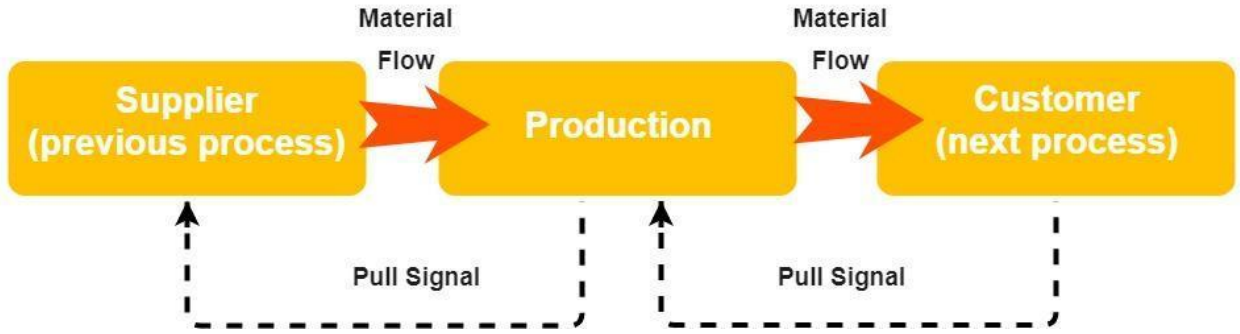

Figure 6. Kanban Pull System (Modified from Vatalaro and Taylor, 2003)

The quantity of Kanbans required for some procedure, initially a requirement test and a limit investigation must be led (Vatalaro and Taylor, 2003). Requirement test decides the present everyday order for each procedure, which should be possible utilizing verifiable order plans yet ideally with current booked demand. Capacity test decides the real limit with regards to the specific item. This data is utilized for the computation of the genuine number of Kanbans required by the framework.

$$\text{Number of Kanbans} = \frac{Daily\ Demand \times (Order\ Frequency + Lead\ Time + Safety\ Time)}{Container\ Quantity}$$

Daily Demand is the existing amount level of day by day interest for a component. This number must be recalculated regularly as demand fluctuates after some time. Order recurrence signifies to the frequency at which the expending procedure will put orders to the providing procedure for a component. Lead time is a gauge of to what extent the expending procedure should wait for an

item once renewal has been approved. Safety time is designated to make up for the effect of waste on the providing procedure. This number is likewise conveyed in days. Container amount is an institutionalized number of units of every item that a container will hold. Of the considerable number of components of the kanban condition, the container size gets the most degree of freedom for change (Vatalaro and Taylor, 2003).

Another estimation, which is required for kanbans, is the assurance of the run line. Run line is determined as below:

$$\text{Run Line} = \frac{(Daily\ Demand \times Order\ Frequency)}{Container\ Size}.$$

After the quantity of kanbans and the run line has been calculated, the most extreme and normal measure of stock can be determined just as the production lot size for each product.

Maximum Inventory = Number of kanbans × Container Quantity

Average Inventory = Daily Demand (1/2 Order Frequency + Safety Time)

Lot Size = Run Line Value × Container amount

In order to get these numbers used to decide the implementation strategy for kanbans, Vatalaro and Taylor recommend leading a value stream mapping operation (Vatalaro and Taylor, 2003).

2.1.7. Boundaries to Lean Implementation

Regardless of the outstanding praise that Lean has displayed throughout the years. Studies who are said to be inside the Lean development and those outside, have both indicated out accurately the different holes in Lean reasoning. The weaknesses of Lean have happened because of presentation of Lean reasoning into various parts and as Lean advances on its underlying segment (Hines, et al., 2004).

They stipulate that most extreme significance ought to be accentuated on the types of frameworks that enable representatives to examine circumstances, urge workers to utilize their own insight in comprehending specific circumstances for development (Hines, et al., 2004). A few creators have condemned that these talks distinguished in absence of inking need maintainability in a large number of its change programs. These technique developments and sending apparatuses important

to accomplish the ideal arrangement is outright not rested legitimately in the administration settings.

Besides, there has been patterns that exit with the utilization of ideas from the examination led in the assembling procedure apply to that of the administration part. At the point when seen from the Marxists focal point, Lean has been named as exploitive and stresses the shop floor specialists (Hines, et al., 2004). The human analysis part of Lean by the different scrutinizes are connected to the way that Lean is excessively centered around apparatuses and procedures as opposed to concentrating on human measurements, for example, inspiration, regard for individuals and representative strengthening. In the end, despite the fact that there are various research and studies concerning Lean in people in general segment, there are holes in the field that require thought.

2.1.8. Advantages of Lean Implementation

The principle upgrades with Lean were correlated with the decrease of lead times for clients, less utilization of stock, increasingly productive utilization of procedures, learning the management development (Melton, 2005).

Different advantages from Lean are accomplishing gain, enhancing the overall situation, increasing services, expanding quality and practice institutionalization (Sohal and Egglestone, 1994). With Lean usage, there were numerous upgrades, for example, decline of process duration in supply chain network by half, enhanced client order perfectness by 25% and stock decrease from producers by 30%. Besides, the execution of Lean decreased active obstructions. In an investigation of manufacturing organizations in Australia, Sohal and Egglestone (1994) confer about that 74% of them encountered structural alterations by straightening their structure because of the execution of Lean. In addition, different changes that brought advantages were decreasing the workforce, enlisting skillful workers, just as worker enablement, which expanded their self-rule.

Few positive elements are the expanded workers ability, quicker work consummation, diminished dissatisfaction with enhanced consumer loyalty to the organization (Petersson et al., 2010, p. 18). Hanna (2007) additionally examines that Lean encourages organizations to alter their method for

critical thinking capacities along with standardizations. In addition, it increases enablement of workers, quicker the delivery time and ensure a better quality (Petersson et al., 2010).

Lean implementation also advantageous for financial services. Atkinson (2004) gives a case of financial services that profited from Lean. Their objective was to rationalize the credit endorsement procedure so as to enhance clients' service. The issue was the complicated procedure that included numerous stages. The period to finish the procedure was decreased by 60% by eliminating fourteen stages. Frost (2007) examined about a bank that rearranged the structures for credit endorsement by three days, which developed quality and increased the value to clients.

Table 1 condenses these advantages in both manufacturing and services industries with Lean practices.

Table 1. Benefits of Lean Implementation

Authors	Book/Journal	Industry	Identified CSF's
Melton (2005)	Chemical Engineering Research and Design	Manufacturing	- Elimination of lead times for clients, - Reduction in inventory use, - Processes are utilized in more efficient way, - Improvement of management of learning, - Financial benefit and reduction in rework
Sohal and Egglestonz (1994)	International Journal of Operations	Manufacturing	- Attaining competitive benefit, - Increasing financial position, - Developing service management, - Improving quality and - Process standardization

Petersson et al., (2010)	Lean-Turn deviations into success!	Service	- Increased workers' capability, - Quicker work accomplishment, - Decreased frustration with increasing client's satisfaction and - Economic advantages to the organization
Piercy & Rich (2009)	European Journal of Marketing	Service	- To recognize non value added activities.

Some authors concurred in two advantages from Lean, where one is about the individuals that lean will develop the self-esteem and skill of the employees and another advantage is to dealt with the procedure that is standardization of process or methodology which will rising the effectiveness (Melton, 2005; Sohal and Egglestone, 1994; Petersson et al., 2010, p. 18; Hanna, 2007; Westwood et al. 2007).

2.1.9. Critical Success Factors

Rockart (1979) has characterized the CSFs as the set number of areas in which results, will guarantee effective competitive performance for the organization if they are satisfactory. Critical success factors (CSF) are significant to the accomplishment of a program and if the goal associated with the factors are not accomplished, the program will likewise prompt failure (Rockart, 1979). Boynton and Zmud (1984) indicated that the CSFs are "those couple of things that must go well to guarantee success". The CSFs are the activities and procedures that can be controlled by the administration to accomplish the organization's final objectives (Brotherton and Shaw, 1996). Any improvement activity implies high expenses, venture (Ranjan and Bhatnagar, 2008) and higher possibility of risk for the organization (Umble et al., 2003). So, it is critical to recognize the variables that can decide the achievement of the implication and maintain a strategic distance from the danger of failure. In the event that these CSFs are not accentuated, not just there could be a critical distinction in the achievement gained, yet in addition losses of exertion, time and cash

(Coronado and Antony, 2002). The CSFs are fundamental parts that must be addressed by the executives or the supervisor to guarantee that 'things must go appropriate' for a task or action to accomplish the management goals and business development. With regards to Six Sigma venture usage, CSFs speak to the fundamental fixings without which the implementation stands minimal possibility of successful accomplishment.

Four key factors recognized by Achanga et al., (2006) that are essential for the execution of lean manufacturing in small enterprises. These factors are financial capability, aptitude, leadership and management and lastly organizational culture.

According to Rathje-Scherrer et al., (2009), the success of lean implementation depends on –

- Provision for the management's dedication and contribution in the work skill;
- Given the chance to employees to settle on modifications in business forms;
- Transparency in information in slightest objectives;
- And indication of developments in the preliminary performance and feeble supportability.

The six instructions for compelling lean usage are: lean won't prevail without noticeable administration responsibility; create formal systems to empower freedom; spread medium-term lean manufacturing goals; ensure there are understandings for the long haul manageability of lean; convey few advantages from the beginning; nonstop evaluation amid lean exertion is crucial. (Rathje-Scherrer et al., 2009)

The types of obstruction in lean implementations are protection from a power blackout, new schedules, change and the condition of infrastructure, which are distinguished by Cheng and Yew, (2011). An investigation of the literature research by Skrudupaite and Jucevicius (2011) uncovered the accompanying key achievement factors in the administration of Synchronized Production System (SPS) application procedure: marketable strategy and vision, management provision (considering investment also), venture management along with venture promoters and cooperation and arrangement, Transformation of management, effective correspondence, organizational culture, learning exchange, training, knowledge organization including skills, organizational infrastructure, observing and assessment of results, measuring performances.

Kumar et al., (2009) distinguished the significance of the accompanying basic achievement factors in actualizing Six Sigma. They are contribution and the executive's obligation, the nature of the

association with the worker, cultural exchange, training, the extent of the affiliation with customer, communication, venture assortment, connecting nature of enterprises, the extent of the relationship with the provider, project detail, organizational structure, provision and objective, data innovation and advancement.

According to Kettinger and Grover (1995) a noteworthy change in the progression needs the accompanying success factors – key funding directors performing as pioneers in characterizing and conveying the change vision, the craving to learn, readiness for culture, recalled connections framework, information exchange, set procedures and change the management techniques lies mostly in executing lean. Pedersen and Huniche (2011) identifies the accompanying elements are imperative for the execution: objectives and qualities, convolution and significance, stability of power and lastly the assets and capability.

The following recommendation CSFs for developing nations are founded by Zargun and Al-Ashaab (2014) and are classified into four main types: -

Table 2. Summary of CSFs of Lean for developing nations. (Adapted from Zargun and Al-Ashaab, 2014)

Strategy and objectives	Leadership and management	Human resources	External factor
Clear target and Common understanding of direction	Top management support and commitment	Providing workers with continuous lean education and training	Communication and cooperation
Consistent focus on continuous improvement	Identifying the need of lean	Ability and willing ness to change	Understanding customer values
Credible planning for campaign	Effective motivation and reward system	Champion and change agenda	Tax laws ,trade agreements ,political environment
Change of organization directions	Leadership style	Multidisciplinary team work	
Systematic conversion strategy	People involvement		
Organizational structures	Knowledge transfer and training		

As indicated by (Sim and Rogers 2009), the issues most processes are: an absence of comprehension of lean, absence of communication and authority. The impediments that help the execution can be overcome with breakthrough planning, transformational administration, great communication, recognize and exchanging of best practices and most importantly a vision. Henderson and Evans (2000) recorded seven segments for the effective execution of lean six sigma as senior administration support, training, measuring techniques, organizational infrastructure (OI), tools, and related work force-based measures.

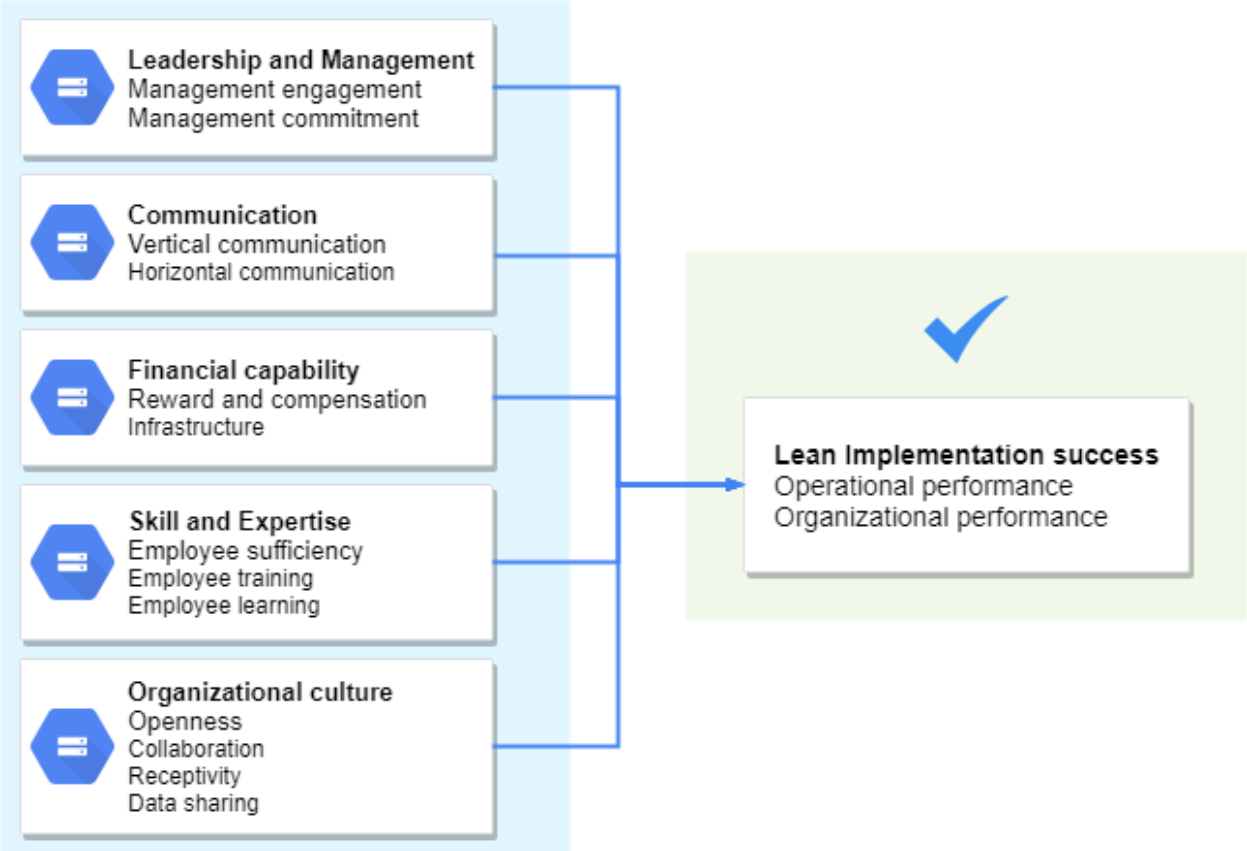

Figure 7. The CSFs for the accomplishment of lean manufacturing (Modified from Bakas et al., 2011).

Bakas et al., (2011), distinguished in his investigation of Norwegian and Belgian SMEs that was held in the European research venture European Regions for Innovative profitability (EIPP). Six proposed basic achievement factors, which is steady with past research are –

- Guaranteeing a strong management commitment.
- Developing with the help of employee participation
- Emphasis on making the motivation to finish the initiatives
- Allocate the adequate time to set up the organization.
- Create competence internally in the organization.
- Set up a performance evaluation system in the organization.

Table 3. CSFs of Lean Manufacturing

Factors	Authors
Human Resource	Seth and Gupta (2005); Shah and Ward (2007); Sahoo ei al., (2008); Gurumurthy and Kodali (2009);
Organization culture and Transformation in Management	Henderson and Evans (2000); Coronado and Antony (2002); Motwani (2003); Seth and Gupta (2005); Doolan and Hacker (2005); Worley and Doolan (2006); Bhasin and Burcher (2006); Sahoo et al., (2008); Czabke, Hansen and Doolen(2008); Gurumurthy and Kodali (2009), Mefford (2009); Mostofa et al., (2013)
Employee Participation and Belief	Motwani (2003); Kotter (2007); Czabke, Hansen and Doolen (2008); Mefford (2009); Mostofa et al., (2013)
Readiness to knowledge, Skill and Proficiency	Henderson and Evans (2000); Coronado and Antony (2002); Motwani (2003); Hines (2004); Bhasin and Burcher (2006); Womack (2006); Shah and Ward (2007); Kotter (2007); Mostofa et al., (2013)
Communication and Administrative Commitment	Wafa and Yasin (1996); Henderson and Evans (2000 Coronado and Antony (2002); Motwani (2003) ; Crute et al., (2003) ;Seth and Gupta (2005); Doolan and Hacker (2005); Worley and Doolan (2006) ; Bhasin and Burcher (2006) ; Shah and Ward (2007); Kotter (2007); Sahoo (2008); Czabke,Hansen and Doolen(2008); Gurumurthy and Kodali(2009); Mefford(2009); Mostofa (2013)
Performance Monitoring	Seth and Gupta (2005); Doolan and Hacker (2005 Womack (2006) Shah and Ward (2007); Sahoo (2008); Gurumurthy and Kodali (2009); Mostofa (2013)
Financial Capability and Budget	Seth and Gupta (2005); Shah and Ward (2007); Gurumurthy and Kodali (2009);

Customer Participation	Doolan and Hacker (2005); Shah and Ward (2007); Kotter (2007); Gurumurthy and Kodali (2009)
Provision and Strategy	Wafa and Yasin
Process Management	Henderson and Evans (2000); Coronado and Antony (2002); Doolan and Hacker (2005); Bhasin and Burcher (2006) Shah and Ward (2007); Sahoo (2008); Gurumurthy and Kodali (2009); Mostofa (2013)

Theoretical CSFs according to table 3 for lean practice execution developed by authors, in light of the basic literature review. Critical Success factors are gathered as an enabler of lean practice and its relations among them for a fruitful execution. It likewise contains the strategies, standards, and procedures required to embrace lean practice all along the organization. Lean as an incorporated quality management practice, that influences the whole organization and its partners - providers and different employees, clients, and so on.

2.2. Textile Industry

The textile industry is a significant section for economy of a country and instantaneously adding to the national economy of various nations particularly in the developing countries. (Dicken,1998, Jones, 2002, Dickenson, 1995). The textile industry has been assuming a pivotal job in the financial improvement in various nations on the world, for example, China, Hong Kong, Sri Lanka, India, Vietnam, Mexico, and so forth. In Bangladesh, specifically, this industry assumes a critical job in the financial improvement concerning about creating employment and gaining of foreign market trade. It utilizes a substantial number of individuals, that workforce mostly dominated by female worker. The stress set on firms in the textile industry from worldwide challenge and dynamic modifications in the retail area have been huge. The expansion in competition has prompted an expanded emphasis on consumer loyalty as a survival of the organization over the long period of time (Kapuge and Smith, 2007). In the present competitive business world, firms are battling against one another to guarantee their survival. The textile industry is likewise exploring for ways and procedures to cut expense and improve execution. At the point when different enterprises are

confronting high stress from contenders, the textile industry is similarly confronting difficulties, for example, cost, delivery time, service, and management and so on. This industry has chances to improve, yet requires a few changes. Under this very competitive condition, the Textile industry has various chances for development utilizing lean standards (Mercado, 2007). Through the execution of lean the textile industries can decrease costs, just with increment of client approachability through lessening a few sorts of waste from the production procedure. Clients request quality items and on-time conveyance. Lean practices can satisfy these prerequisites by decreasing lead-time just as production process duration or cycle time. Presently, numerous nations have begun to rehearse lean instruments in the textile industry and watched enormous improvement (Mazany, 1995; Bruce et al., 2004). This exercise has improved their efficiency, quality and lead-time and furthermore made their client increasingly responsive. Notwithstanding this lean manufacturing includes, inspires and create worker aptitudes through instruction and multi-skilling program (Mazany, 1995).

Garments industry is a labor intensive industry which mostly utilize low technology (Rashid, 2006). Because of foreign challenge, the readymade garment (RMG) segment of textile industries which is abundant portion of textile industry in Bangladesh is confronting demand level for additional styles, shorter cycles of production and in smaller orders. The worldwide business situation of the readymade garment industry is evolving quickly and is vigorously depends on lead-time and cost. The business itself should be reorganized and repositioned (Spinanger, 2001). In this crucial circumstance, lean manufacturing expects to lessen lead-time and cost by decreasing different sorts of waste from the production procedure. A few nations are doing very well in textile production while others linger behind. Till the mid 1980's India and Sri Lanka were the significant South Asian providers of readymade garments to the USA and Western Europe (Spinanger, 2001). India is using this industry for financial development (Dicken, 1998; Jones, 2002; Dickenson, 1995). The Indian textile industry has turned into a noteworthy market globally. The USA and Bangladesh keep on being the biggest markets of Indian Cotton. At the point when India has situated itself in the universal market, in view of large scale textile industry, Pakistan has additionally achieved dependable position globally. Which is right now the Pakistani textile industry being in a stale condition in view of higher manufacturing costs. One of the greatest exporters of materials and textile is China (HKCIC, 2004). The Chinese organizations can deliver items at short notice which gains them an upper hand. Research has likewise demonstrated the

significance of the textile industry in the economy of Fiji. It is uncovered that, in Fiji, the textile industry turned into a basic piece of its financial structure. Preceding 2000, it was sending out more than 300 million Fijian Dollar worth textile to Australia, the USA, Europe and New Zealand. The piece of clothing industry is contributing essentially to the Fiji economy. While a few nations are doing very well in this industry (Bruce et al., 2004) demonstrates that the textile fabricating industry of United Kingdom (UK) has been confronting serious issues amid ongoing years. As per Warner (2001), globalization is a central point influencing the UK production industry and competition with the low labor cost nations is the most concerning issue. Work, working conditions and wages are some basic political issues in the overall textile area. In Australia, the textile industry has prospered dependent on outsourcing. Its influence on the Australian economy is likewise important, representing around 10% of the production industry (ANZ, 2005).

The worldwide export of textile has considerably expanded in 2005 (US$ 275.6 billion with a development rate of 6.4 percent) (Rahman et al., 2007) because of the elimination of the MFA (Multi-Fiber Arrangement). MFA is an agreement about quota restriction on trade textiles between individual developed nation importers and developing nation exporters. The quota allows the exporter to supply a specific volume of textile items up to a predefined ceiling and it is dependent upon the exporter to apportion the quota recompense among its domestic producers (Rahman et al., 2007). Bangladesh is presently under incredible challenge. It turns into an imperative for Bangladesh since it opens free market for different contenders too. The following segment will give an outline of the Bangladeshi textile industry.

2.3. Textile Industry in Bangladesh

Already, the jute and tea ventures were the biggest export focused industry of Bangladesh (Rahman, 2004). A similar report revealed that progressively the production sector, particularly the textile industry, has gotten more noteworthy consideration. Since 1980 Bangladesh is the fastest growing textile exporter among around two dozen exporters (Spinanger, 2001). The textile industries in Bangladesh remain as a one of a kind case in developing countries which has took the advantage of taking part in the worldwide economy for quick monetary advancement encouraged by trends in globalization. Connecting to the authentic improvement of textile businesses in Bangladesh an investigation of Bair and Geriffi (2002) can be considered. They have

depicted the movement of textile manufacturing in four recognized stages in their examination. As per Bair and Geriffi, (2002), the primary relocation occurred during the 1950s and the mid 1960s from North America and Western Europe to Japan. In the second stage Japan changed the equivalent to the Asian Tigers-South Korea, Taiwan, Hong-Kong, and Singapore in 1970's. These Asian Tigers change the production to other developing nations in particular the Philippines, Malaysia, Thailand, Indonesia and China in the third period of movement (CAFOD, 1998). The fourth stage incorporates Bangladesh, Sri Lanka, Pakistan and Vietnam in 1990's. In regard of industrialization, Bangladesh generally lingers behind even the major subcontinental nations, for example, India, Pakistan, and Sri Lanka (Mannan, 1993). The textile sector of Bangladesh are exceedingly alluring for foreign speculators. Since the late 1970s, the completely export based textile industry of Bangladesh has seen huge development (Rashid, 2006). Nations, for example, India, Pakistan, Sri Lanka, China and Vietnam are the principle contenders of Bangladesh in the textile sector. This competition lead to reduce waste cost and cycle time along with delivery time. This sector has shortcoming in certain zones, for example, absence of decent variety and diversity in export market, long-lead-time and so forth (Rahman, 2007). Because of the solid challenge, Bangladesh has made huge improvement in demonstrable skill, supplier and provider network, shortening lead times, maintaining quality, human asset and so forth. (Rashid, 2006). Bangladesh has increased significant consideration from created nations because of the low work cost and quality item. As far as fare, the nation is picking up a superior spot in the fare segment. Its fares are bit by bit expanding in a direct manner. For instance, Bangladesh's export of RMG expanded from US $ 40 thousand out of 1978-79 to U S $ 6.4 million out of 2004-05 (Rashid, 2006), which is now around 30 million US $ in 2017-18 fiscal year (BGMEA, 2018). In employment issue, its support is significant in that it utilizes more than 3 million specialists of whom 90% are women (Begum, 2001).

Before eliminating, the MFA in the North American market and particular market access to European markets were leading factor for the accomplishment of the Bangladeshi textile industry (Rahman et al., 2007). Low work cost is another factor of achievement. As clarified by Warner International (1998), when the hourly attire work cost of Bangladesh is just $0.30, it is $ 10.12 in USA. Bangladesh is in a solid position in the worldwide market. This is apparent from the fact that the development rate of textile export in Bangladesh is essentially much higher than a few in number contenders, for example, Indonesia, Mauritius and Dominican Republic (Rashid, 2006).

Bangladesh exports RMG with more than 17% to USA, 64% to the nations in European Union and 3 % to Canada and different nations of the world (BGMEA, 2018). This overall market circumstance significantly influences the business activities of the organizations under the present review. These organizations are additionally exporters to these nations that provoked them to utilize lean methods for development of value and the product delivery for the shipment.

3. Methodology

3.1. Methodological Approach

A research flow chart diagram was considered to give the flow of the proceedings done for this research. The accompanying diagram gives a straightforward exhibition of the methodological procedure of this investigation and the research flow diagram utilized in the exploration.

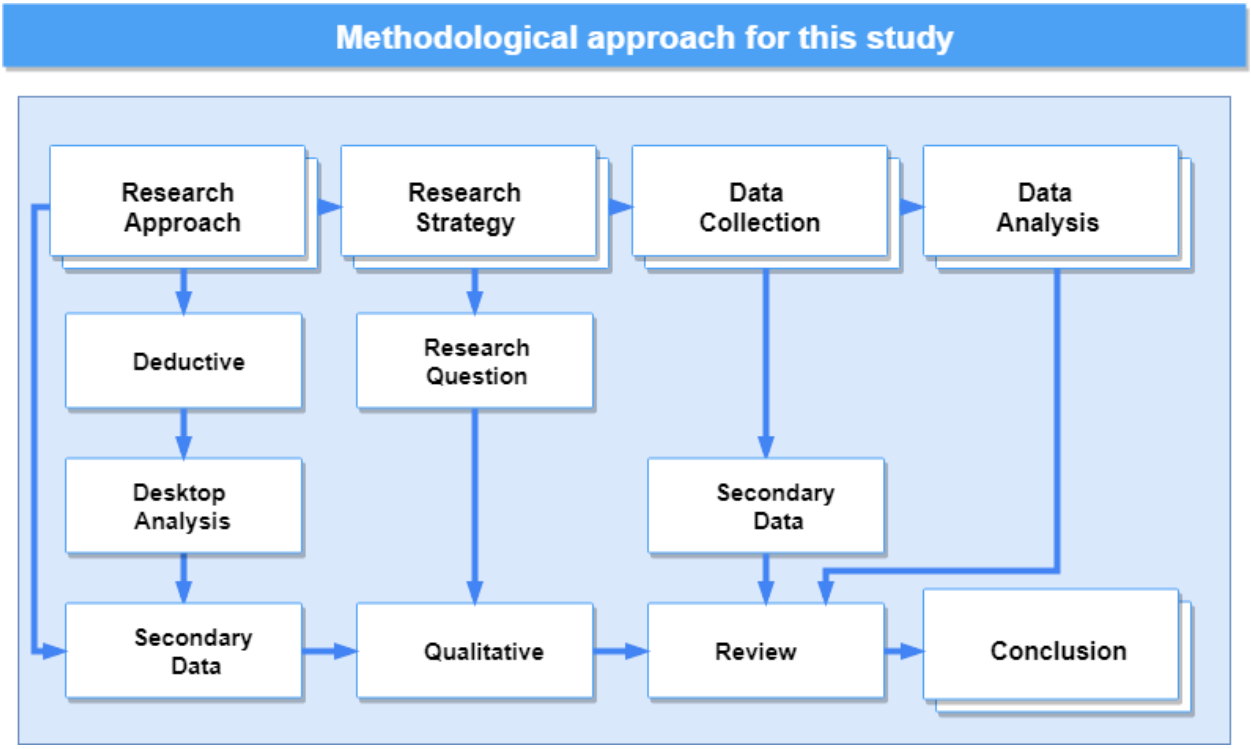

Figure 8. Summary of methodological approach of this study.

Figure 8 demonstrates the sort of research advances forward; plan and procedure and data collection system have been directed in this research. Nonetheless, to satisfy this research, among different accessible research strategies qualitative method has been selected for secondary data. For the more in-depth study desktop analysis has done to explore the available open sources. In this postulation the empirical findings are examined with qualitative, evocative analysis method to look into potential business areas etc. These subjective investigations will address three research questions. The majority of the information of this perception and this exploration has been accumulated from on the web.

3.1.1. Research strategy

This thesis mainly based on qualitative research methodology. This research methodology focuses more on analysis dependent on words instead of measuring the data numerically. Its emphasis is on inductive way to deal with produce a hypothesis, just as the research rationality of interpretivism (Bryman and Bell, 2007). This method of research is tied in with discover answer and implication from analysis of human conduct. This is the reason qualitative research is adaptable with regard to structure and methodology for the data collection, which gives the analysts adaptability to adjust, based on the discoveries of the observation or conditions (Rubin and Babbie, 2010).

3.1.2. Case Study

Case study includes a thorough examination inside a case. There are two sorts of case studies. The primary type is when there is set number of cases to concoct common conclusion. The second one is the point at which the focus is in a solitary case, determining particular ends (Gummesson, 2000). This investigation based on the first kind as it includes a different case. Saunders et al. (2009) clarified the case study in least difficult terms, which empower analysts to answer the 'why, how and what' research questions (Bryman and Bell, 2007). Thorough research has been directed to explore the pertinence of current Lean instruments and procedures in Bangladesh with comparison to other lean implementing organizations.

3.1.3. Data Sources

In this study, primarily secondary data is used. Secondary data, which are the information gathered from effectively distributed research works are similarly as imperative in inquiries about, were additionally acquired from such sources as conference paper, articles, books, research paper work, past archives, thesis work and yearly reports from the published archive and other web-based assets.

3.1.4. Approaches of data analysis

The methodology utilized in this study to analyze the information collected, depended on deductive research where appropriate theories are introduced to find the answer of the research questions. The following research design has been used in this study:

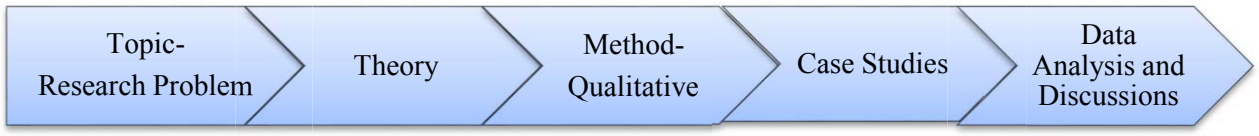

Figure 9. Research Design (Adapted from Saunders et al. 2009)

One data analysis approach that was utilized to perceive how the data obtained from the case studies differ with one another. There are two central methodologies utilized in analyze qualitative information, though each methodology can be dealt with in various ways, these methodologies are known as the deductive and the inductive methodologies.

4. Empirical Study

This chapter will focus to analysis the extent of practicing the lean tools in the textile industries of Bangladesh, implementation of lean tools and the improvement in the production system are also discussed. This chapter will also provide a comparative case study among the India, USA and Bangladeshi textile industry and also convey the findings on benefit generation by the implementation of lean practices.

4.1. Lean management in Bangladesh- Case Studies

In this case study nine textile industries took into account for studying lean practices. The companies produce numerous types of apparel products. Lists of garments manufactured by various companies are schemed in Table 4. This table demonstrates that the industries produce a wide range of readymade knitted products for all men's, ladies' and children's such as knitted tops, bottoms, trouser, shirts for kids, skirt, T-shirt, Polo T-shirts, Tank Top, etc.

Table 4. Industries of this case study and their products (Adapted from Ferdousi, 2009)

No.	Names of Companies of the case study	Products Produced by the Companies
1	Fashion Point Ltd.	Pique Polo, Basic Fancy T-Shirt, Basic Tank Top, Fleece
2	Texas Fashion Wear Ltd.	shirt with fancy design, Fleece Jacket, and Sweat shirt
3	Beximco Fashions Ltd.	All sorts of bottom and tops in Denim. Twill, Dress Pants
4	Shanta Industries Ltd.	and Denim Jackets
5	DADA Ltd.	Men's dress and casual shirts and ladies blouses
6	Shanta Wash Works Ltd.	All types of woven Tops and Bottom
7	Armana Fashions Ltd.	All kinds of headwear of different styles and designs
8	Shanta Denims Ltd.	Woven tops and bottoms for children/ ladies/men as well
9	PAXAR Bangladesh Ltd.	as overalls and shortalls for infants and kids

In this case study the companies are international joint ventures, public limited and private limited companies listed under the Bangladesh Companies Act, 1994. From this investigation's analysis of data, it is evident that legal status of different types of companies exerts not much differences in lean implementation. So, it acts that legal status several of companies has slight effect over lean practices. Among the companies took into account in this case study 56% preferred a team oriented flat organization workforce framework, others had tall workforce framework.

It is evident that team oriented working organization is a significant property for the lean manufacturing frameworks which includes adaptable, multi-talented management employees taking a high level of obligation regarding work inside their regions (Sohal, 1996). Conversely, practical structure comprises of the CEO with well-designed line-managers in prevailing

authoritative zones and that considers useful specialty along these lines limiting learning involvement and idea sharing development (Mannan, 2000). Companies took account for this case study are maintaining quality parameters from various buyer such as, GAP, M&S, Polo, NEXT, J.C.Penny, Walmart, Target, PVH etc. These buyers have specific international quality system for in-house management.

The principal sources of raw materials and machineries are from foreign countries (89%) along with domestic suppliers (56%). The benefit of using domestic suppliers for components and raw materials required a less inventory time. Although, some material has to be collected from foreign sources. In this case study one of the organizations need to import completely (100%) of the raw materials and the others import between 20 to 97 percent of components and raw materials from foreign sources, which leads longer time inventory. Major parts of companies acquire raw needs from foreign and local suppliers directly (56%) through letter of credit while 1/3 of them collect from tendering. But the tendering method is the 'counter hypothesis' of a lean framework. In lean practice for total quality control, long-term relationship with suppliers is a major component but the tender leads to a short-term relationship. In this case, it is uncovered that however every one of the organizations plan to retain long and stable association with the providers and suppliers, yet they are defying lean by following the tender method of procurement.

For progress, lean generation requires a small number of provider base and for that there is a need of Just-In-Time (JIT) process. JIT framework requires convenient conveyance of items which is easier through small number of provider base. Likewise, maintaining a decent association with a larger group of providers is extremely troublesome. However, on account of the overviewed organizations, nearly half of them have a huge provider base as they collect raw materials ranging from 11 to 50 supplier sources which clearly indicates a conflict with lean thinking. Besides, among the companies just 22 % of the companies could lessen the huge number of providers in five years of lean practicing (Mannan and Ferdousi, 2007). So, it is extremely incomplete about the effective practice of lean on these organization. To improve this circumstance organizations may need to survey and assess their providers and sort out a small group of providers and suppliers. Which can assist them with establishing a reliance-based association with small group of providers.

4.1.1. Implementation of Lean Tools

Lean manufacturing systems needs different kinds of processes for the implementation. From the study it is uncovered that the organizations were utilizing a few lean tools. It is apparent that the pull production framework was adopted by all organizations and 66% of the organizations utilized Kanban for movement of materials between the processes of production. Kanban is a critical instrument of lean production framework. Amid the reviewed organizations 66% of them had the Kanban framework and the staying 33% had no such framework. In the Kanban procedure one third of the organizations were utilizing digital media like server based order framework and one process unit is connected with another process units with networking. This is pursued by the utilization of compartment or sheet. Some organizations using pull and Just-In-Time however not Kanban were utilizing oral guidelines instead of Kanban.

Table 5. The different lean tools and their extent industries have implemented (Adapted from Ferdousi, 2009)

No.	Lean techniques	Percentage
1	Kanban	66
2	Daily schedule adherence	100
3	Small lot size	100
4	Just-in-Time	100
5	Physical arrangement of equipment	89
6	Application of preventive maintenance	89
7	Pull production systems	100
8	Continuous improvement	78
9	5S	44
10	Other quality practices	100

Just-In-Time is a major component of lean production. 100% of the organizations are utilizing JIT. Kanban is likewise a vital piece of JIT that causes association to decrease the extent of stock through convenient movement of products from one process to another as per the order demands. This study demonstrates that all providers are very trustworthy as far as convenient at conveyance just as successive conveyance of materials to the organization.

The organizations collect components and materials from both local and foreign providers and just the local providers are engaged with the successive and frequent conveyance of materials. An investigation of data likewise demonstrates that 78% of providers are connected with the organization by pull frameworks and that the organizations have partnership association relations with the providers. It is obvious from table that most of the organizations are subject to a bigger provider base and 33% of them obtain materials through tender. In the principal case, maintaining a partnership oriented and pull system relationship with a high number of providers is troublesome. Then again, tendering for obtainment of materials shows a powerless association with providers. While 56% of the organizations get every day shipments from local providers which reflect utilization of JIT, the rest of the organizations have room schedule wise time to time conveyance since they get foreign providers. (Ferdousi, 2009)

Table 6. Procuring raw materials and components: Number of local and foreign providers. (Source: Ferdousi, 2009)

No.	Number of providers of raw materials (local and foreign)	Percentages
1	1-10	33
2	11-50	45
3	>50	22

Table 7. Procuring raw materials and components: Source of procuring. (Source: Ferdousi, 2009)

No.	Source of raw materials procuring	Percentages
1	Direct purchase from providers (local and foreign)	56
2	Tendering	33
3	Headquarters	11

Meanwhile a few providers cannot deliver items on time it shows an absence of a JIT framework in a few organizations - in spite of the fact that these organizations guarantee that they have JIT framework. The study presents the information identified with various lean systems embraced by the studying organizations. The information demonstrates that 78 % of the respondents guarantee to have been rehearsing ceaseless improvement, which is Kaizen and have incorporated quality with plan, which is a fundamental routine with regards to lean. Every one of the organizations have Quality Control frameworks. In 22% of the organizations the laborers do the quality examination and the remaining have separate quality control group. In light of the inquiry whether they stick to day by day plan, all organizations meet the component, which is basic for lean maintain to a day by day plan (Phan and Matsui, 2007). The more noteworthy the adherence, the more prominent is the capacity of the organization to keep planning for the production. The present examination researched the utilization of 5S in the studying textile industries.

Less than 50% of the organizations were found to utilize 5S to some degree. This shows the rest of the organizations may have a few components of 5S, yet they don't have clear comprehension about the strategy. Among various lean techniques, 5S is a standout amongst the most speedy and simple to execute. This is on the grounds that skilled workers can help actualize 5S program in the organization without extra assets. However, when organizations are following other complex lean strategies than 5S, this can be taken as a sign of absence of genuinely lean management in the organizations. The study demonstrates that the organizations are on the whole effectively meeting the general production plan each day. All organizations asserted that they can meet the everyday manufacturing schedule and they are never be late on schedule. The organizations specified the target schedule through a visual management method to pursue who are running behind that scheduled target. Everyday production plans for their organizations are set up so that the schedules permit adequate time for machine interruptions and sudden production halt.

The majority of the organizations have strategies for precise and customary support of machines which inhibit interruptions of machines. Lean manufacturing requires the concern of the management of hardware which implies the machine design into production units and establishment of machines as per JIT production stream. Except one organization the rest don’t have appropriate strategy for machines and hardware. Because of absence of space they couldn't

arrange the gears and equipment's legitimately though all of the organizations have very much up-to-date standard apparatus just as astounding material dealing with framework.

The implementation of Total Preventive Maintenance (TPM) is a significant tool of lean manufacturing since it is a lean machines and equipment support methodology for amplifying total equipment viability through enabling employees to maintaining and improve activities (Manos, 2002). The greater part of the organizations of 89% have received Total Preventive Maintenance method and they have a standard program of cleansing and adjusting machines and a formal fix calibrating framework. Contrasted with the pre-lean period, all the studied organizations need less time for one production conduction and starting of next production. However, the time decreased time differs from organization to organization which varies from 1/3 to 3 hours.

4.1.2. Improvement in Production

Every organizations effectively diminished the changeovers time at least to a few degrees. The utilization of small-lot sizes was prioritized by the majority of the organizations with 77 % of them, in order to expand production flexibility and adaptability. It is intriguing that their comprehension of small lot estimate differs from the genuine significance. Each organization has its own significance or measure of small lot estimate. For instance, while one organization showed small lot as ten pieces, another organization saw it as twenty pieces or more. There is no particular or regular measure of lot size to all of the organizations. These varieties in the understanding in measurement are additionally a hindrance to lean. Powerful lean production necessitates a just in time relationship with the clients of completed products. As soon as an organization is in JIT relationship with the clients which implies it has less order to transport process duration. So, it can do the item conveyance works frequently without disturbance. Most organizations of 89 percent can convey items to clients on time. Prior to lean, the greatest order to transport process duration was 120 days and least was 15 days. Afterward lean, the greatest process duration is as of now 90 days and the base is 10 days. This decrease in process duration is noteworthy.

Table 8. Average days of stock in the industries (Adapted from Ferdousi, 2009)

Company	Before Lean	After Lean	Reduction (days)	Reduction (%)
1. Fashion Point Ltd.	90	60	30	33
2. Texas Fashion Ltd.	25	20	05	20
3. Beximco Fashions Ltd.	90	75	20	22
4. Shanta Industries Ltd.	17	12	05	29
5. DADA Ltd.	120	90	30	25
6. Shata WashWorks Ltd.	35	20	15	42
7. Armana Fashions Ltd.	37	24	13	35
8. Shanta Denims Ltd.	-	-	-	-
9. PAXAR Bangladesh Ltd.	90	60	30	33

Decrease in number of days of stock of raw materials prompts decrease in the production waste. The more decrease in time of stock, the more addition as far as waste disposal. Following table demonstrates that the normal number of days of stock was abridged in all organizations, varies from 5 days to 30 days. 50% of the organizations picked up an improvement as far as decrease in days of stock from 20 to 30 percent. Rest of the organizations reduced stock days between 33% to 42%. The industries in the textile and apparel industry can decrease the time of stock holding that cuts stock related expenses.

4.2. Comparative Case Studies

4.2.1. Case Study 1: India

In this section focused around executing lean manufacturing systems in a textile industry in south India, study lead by Saleeshya et al., (2012) a leading textile industry which mainly manufacture fabrics. The organization has separate divisions of textile weaving, dying and processing. This case study mainly focuses on weaving division which has a monthly order of 800,000 meters. Weaving section has different parts, they are raw material inventory, warping, winding, sizing, pattern making, weaving, and quality check, processing and dyeing. Processing and dyeing divisions are treated as outside in this case study. The general format of the organization is appeared in Figure 10. This organization is principally managing two sorts of yarns, for example, piece colored and yarn colored, both in mono shading and in pattern. Piece colored material is one where weaved fabric is colored with one shading consistently. So, the entire procedure of sizing, warping, drawing and weaving is finished with dark yarn and the fabric all in all is colored toward the end. Though, yarn colored material is one where the yarn is colored is at first as indicated by the example given and afterward is distorted measured and weaved.

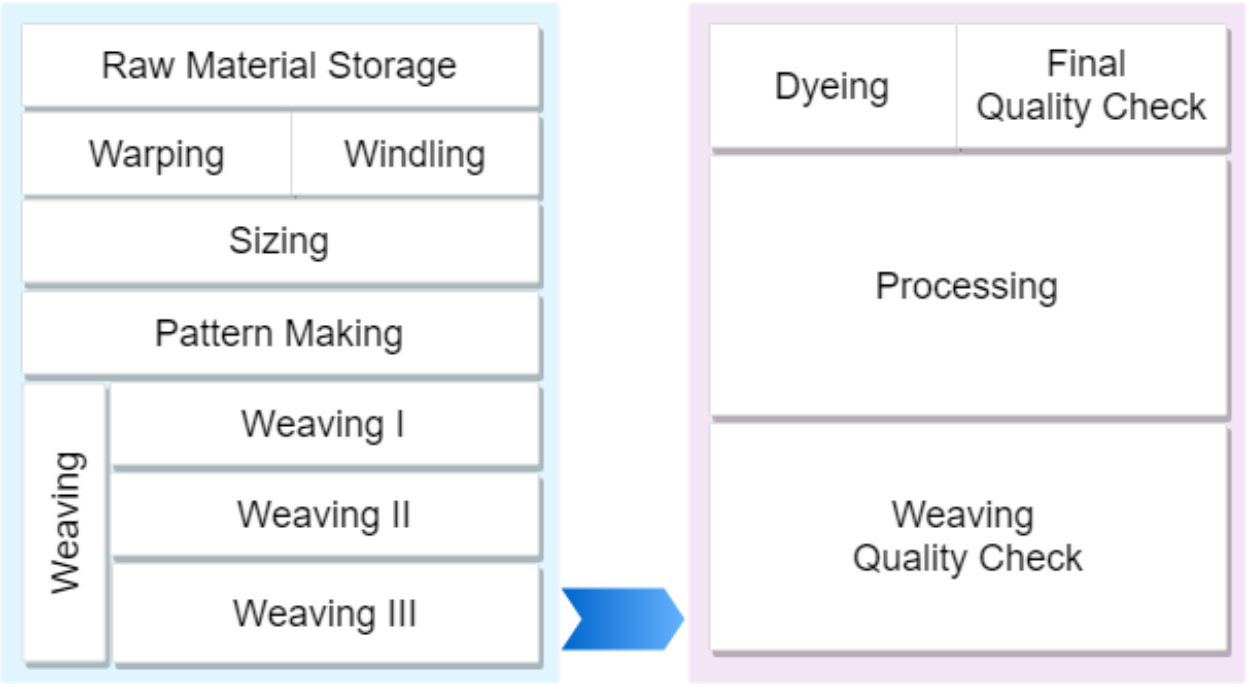

Figure 10. General layout of the production floor. (Adapted from Saleeshya et al., 2012).

Detailed investigation of current condition of the organization

An item experiences different value added or non -value added activities, procedures or stages before being conveyed to the client. These values added or non -value added procedures put into a single unit goes under stream or flow or work process.

Table 9. Summary of procedure information (Adapted from Saleeshya et al., 2012)

Parameters	**Department**							
	Warping		**Sizing**		**Drawing**	**Weaving**		
	Direct	**Sectional**	**Direct**	**Beam to beam**		**Air Jet 190**	**Air Jet 220**	**Rapier**
Processing time (min/1,000 m)	1	1	60	5 (min/100m)	8 hrs	1	1	1
Setup time (min/1,000 m)	45	60	90	35	NA	30	30	30
Changeover time (min/1,000 m)	45	30	45	10	NA			
Transfer time (min/1,000 m)	5	6	7	5	7	13	10	10

The information was accumulated first by huge picture mapping (Mothersell et al., 2008). The significant parameters like cycle time (CT), changeover time (CO), number of administrators, number of shifts was noted. The information was accumulated from raw material inventory to dispatch and for a second time from dispatch to raw material inventory. At that point from the comprehensive view of mapping, thorough VSM was completed. Recorded previous information from the business and the accumulated information on the observation basis and online information of weaving division was made utilization of thorough VSM. Table 9 condenses the information gathered from different divisions.

Investigation of the production status

To continue to the future state, must investigate the present status mapping. The most vital parameter to examine the present state is ‘takt time’. ‘Takt time’ is the required rate of generation to satisfy the clients need on time. It is a hypothetical term. In this case the month to month order is 800,000 meters which converts into a daily based order of 26,667 meters. The organization works on two shift system which leads a shift of 12 hours or 1,440 min. Estimation of takt time will work hours partitioned as per order that is 0.054 min/meter or 3.24 s/meter. While the present generation is 500,000 meters for every month, which implies the working time to deliver one meter of fabric is 5.18 s. The functioning time is more than ‘takt time’ in the extent of 1.6 and that ended up a deficiency of 300, 000 meters toward the month interval. So, the following stage is to distinguish where and why, time is overused and wasted. For this, in view of information gathered and observations, the issues and deterrent in the work environment were organized. These issues like principle factors that add to high CT are recorded in the circumstances and logical results outline as appeared in Figure 11. These issues happen because of manual delay, machine defects, deficient materials, inappropriate strategies. Investigation of the information gathered recognizes high CT, absence of institutionalization, and absence of work consciousness of employees as the serious issues in the industry.

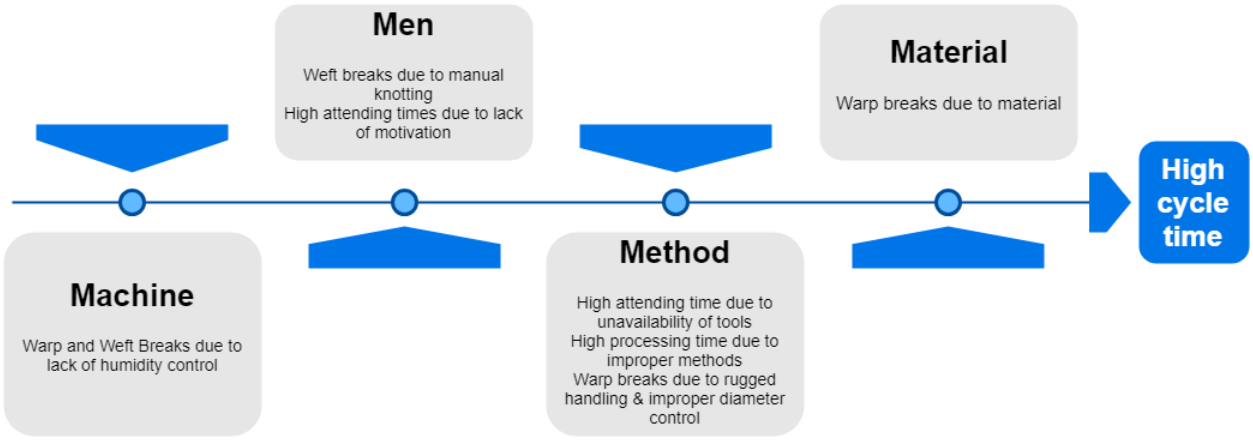

Figure 11 Chart of causes of high cycle time (Adapted from Saleeshya et al., 2012)

The principle factors that add to high CT are, warp and weft breaks, high going to time, high setup and processing time. The weaving machine has a fault demonstrating system framework. A yellow

light gleams for warp breaks and for weft break red light is utilized. At the point when the light shines the allotted employee should go to the machine and adjust the error. The purposes behind the weft and warp breaks are as per the following, inappropriate moisture control, manual knotting, inappropriate diameter control, rough handling of cones, fine count threads.

Relative moistness assumes an important task in weaving and adds value to the yarn quality. Air conditioning is done to keep up ideal moistness in the weaving division. Relative humidity should be maintaining between 70 to 80 percent, to do that the inlet and outlet air conditioning ought to be controlled appropriately. Yet, the manager in control for humidity control does not have appropriate diagrams or tables to control the air inlet and outlet. In the event that there is a variety in the relative stickiness it results in breakage of yarn amid the weaving procedure. Because of this problem warp breaks happen more frequently. This issue is owed to the absence of proper regulation of the moisture and humidity control. In winding division during the threads are twisted and coiled around the cones breakage happens in the string. Knotting is done to fix this problem which is done physically. This occurrence prompts to uneven thread diameter. At the point when these cones are utilized in weaving area warp and weft breakages happen. This issue is caused by the manual pass. Higher pickup is maintained to improve the quality of the yarn. Yarn gets coated by starch to increase the diameter and furthermore the firmness which results in warp breaks. The cones are transported from the winding division to warping and weaving office by utilizing sacks. Inappropriate handling of cones can harm thread which results in weaving process breakage of warp and weft. Fine threads are feeble and they are vulnerable to breakage. The 60s, 70s, 80s are fine threads which are extremely delicate to any change in the process conditions. Warp and weft breaks happen frequently when legitimate consideration isn't given to warping conditions when utilizing fine threads.

A warping machine has two creels, each of which has a limit of 720 cones. There are two sorts of warping. One of them, split warping required more than 720 cones and both the creels are utilized. On the other hand, in single warping less than 720 cones are adequate, where the second creel isn't utilized. The following request is prepared during that time creel. For the following request, when the cones are organized in the second creel the warping machine is inactive. At the point when the warping machine is being used with the primary creel, the second is kept inert. So, both way one creel is under-used amid the procedure. The setup time for organize the creel is 40 minutes. Reed

is an instrument utilized for segregating each yarn for sectional warping. Each warping machine has just a single reed. Amid split warping the reed must be changed which takes around 15 minutes for each. For complex designs it takes more time. At the point when a fine count (count is the measure of thickness of the thread) thread is warped and a coarse count thread have to be organized in the creel for next, the organization of cones face thread breakage issues. This happens because of strain variety between the fine and coarse thread. The issues recognized were dissected and the underlying drivers were discovered through 5W and 2H methods. 5W defines what, where, when, who and why method and 2H defines how and how much method.

Measures taken to improve the leanness of the organization

To resolve various bottlenecks of the organization appropriate lean tools requires. Five lean techniques were distinguished to counter these issues. These are Poka yoke, Kaizen, quality circle, 5S and Kanban. Aside from these, couple of recommendations for HR departments were likewise considered.

Kaizen is a Japanese theory that based on consistent improvement all through all parts of life. At the point when connected to the working environment, kaizen ceaselessly improves all elements of a business, from production to the management and from the CEO to the sequential manufacturing laborers. Kaizen is an everyday movement, the motivation behind which goes beyond mere efficiency improvement. It is a procedure that, when connected effectively, adapts the working environment, removes excessively tough work and shows individuals how to perform scrutinizes their work utilizing the logical technique and how to figure out how to spot and take out waste in business forms. Best kaizen must work with three standards:

- Contemplate the procedure and results, so that activities to accomplish impacts are perceived.
- Precise reasoning of the entire procedure and not simply that quickly in view, so as to abstain from making problems somewhere else in the process simultaneously.
- A knowledgeable, non-judgmental, non-accusing (in light of the fact that accusing is inefficient) approach and goal to permit the reconsideration of the presumptions that brought about the present procedure.

Poka yoke is an approach to make or gather items with least or zero deformities by rehearsing zero quality control (ZQC). It is a technique for no fault procedure. A Poka yoke framework utilizes sensors or different gadgets introduced in processing units or machines to identify mistakes that are missed by the employees. Poka yoke frameworks are utilized to complete two key components of ZQC to be specific, 100% investigation and prompt response. Poka yoke frameworks are utilized in base investigation to get mistakes before the production procedure makes a faulty item. A Poka yoke framework controls the manufacturing and avoids faulty products utilizing one of the accompanying methodologies,

- Control framework stops the machine immediately when an anomaly happens
- Warning framework informs the managers to stop the machine when blunder is recognized.

Quality circle is the idea of value circle depends on human resource executives, which is considered as one of the key variables of on in the improvement of product quality and profitability. It infers the improvement of aptitudes, abilities, certainty and creativity of the individuals through total procedure of instruction, preparing, work understanding and support. The quality circle idea has three noteworthy traits, for example, quality circle is a type of participative administration, it is a HR improvement procedure, and it is a critical thinking system. A quality circle is a small team of volunteers doing comparable work. They meet consistently under the administration of their immediate superior or somebody picked among the hover to identify issues as their significance, find the reasons of the issues, and propose resolve arrangements. They may concern quality, profitability, wellbeing, work structure, process stream, control component, style of workplace etc.

Kanban is a warning framework to trigger activity. Kanban is utilized as a section pull system and needs scheduling which implies just produce item to supplant the item devoured by its clients, and just produce item dependent on order sent by its clients. Kanban replaces the everyday scheduled actions, necessary to run the production procedure, and the requirement for production operators and managers to persistently monitor plan status to decide the following thing to run and when to change over. Kanban decreases stock, improves work stream, anticipates over production, space management at operational dimension, and makes visual planning and the administration of procedure.

By applying different lean tools collaboratively improve the general capacity of the production arrangement of the organization adds to extraordinary changes in the execution of the processes.

Improvements in the system

To move cones from winding division to warping division, utilization of sacs is supplanted with cardboard boxes. This reduces the quality distortion, which further improves the nature of yarn and henceforth lessens the weft and warp breaks in warping process and furthermore while organizing cones in the creels. To build the procedure flow adaptability the accompanying color-coding framework is presented for completed shafts and cones. Red for more than 10,000 m, yellow for 1,000m to 10,000m and green for less than 250m.

This gives greater adaptability in the manufacturing procedure. Greater importance can be given to orders >10,000 m. Employees would have more aware in dealing with the cones and the beams. Void beams are set in a situation from where it tends to be effectively retrieved. Amid single winding just a single creel is use. The idle creel can be coordinated with cones for the following shift. This decreases the inactive time of creel and improves the productivity of warping. Deficiency of tools like scissors and cutting tools in warping are essential and labeled along with the recommendation of specialists. Another essential proposal is to expand the quantity of reeds from one to two for all of the machines which enables the split warping process and empowers the winding of complex designs. The setup time for expelling and again putting the reed from one creel to other can be spared. This saves around ten minutes for each procedure of changing the reed. (Saleeshya et al., 2011)

The time delay in the drawing procedure is because of the ceaseless collation of the threads in the creel as appeared in Figure 12. Because of this constant collation the back to back threads are parallel to one another. This results in disarray amid the drawing procedure. To differentiate back to back threads collation is done as appeared in Figure 13. In this creel collation the back to back yarn are warped in traversed way.

Figure 12. Old creeling Order. (Modified from Saleeshya et al., 2012)

Figure 13. New creeling Order. (Modified from Saleeshya et al., 2012)

4.2.2. Case Study 2: US

To continue competitiveness, numerous US textile industries have looked to improve their assembling forms, so they can more promptly contend with foreign producers. This case study recognizes the distinctive tools and standards of lean. The utilization of lean production in the textile business was analyzed in this case study. A model showed for executing lean techniques and standards in textile context (George et al., 2011). This case study is secondary data, which was first acknowledged by George et al. (2011)

National Textiles of US started their lean assembling execution process in 2004 with the assistance of North Carolina State University's (NCSU) Industrial Extension Service (IES). The organization's objective was to lessen excess wastes and improve profitability (NCSU IES, 2007). Their first lean execution yielded great outcomes, incorporating a 30% increase in profitability and 40% charge decrease in that production units (NCSU IES, 2007). The task actualized such techniques as 5s, principle work stream. The objective of the second lean projection was to improve quantity and stream between two procedures. To achieve this objective, the undertaking

directed 5s exercises, decided process duration and takt time and led a value stream mapping (VSM) practice. The outcome was a decrease in the quantity of pointless set ups by half and a decrease of the system time from 15 to 5 min (NCSU IES 2007).

Table 10. Diverse lean techniques utilized by the organizations reviewed, Source: (George et al., 2011).

Lean tool	**Percent of reviewed Organizations**
5s	100
Cellular manufacturing	27.3
Kaizen	63.6
Kanban	27.3
Mistake proofing	9.09
Policy deployment	9.09
Rapid Improvement	9.09
Six Sigma	54.5
Quick Changeover (SMED)	45.5
Standardized Work	54.5
Supermarket	27.3
TPM	45.5
VSM	81.8
Visual Management	90.9

Table 10. condenses the diverse lean techniques utilized by the organizations of the study. Visual administration had been utilized by 10 of the organizations and 5s, which is also a visual administration had additionally been utilized by these 10 organizations. Value stream mapping had been utilized by nine of the organizations. The 5s was frequently referred to as one of the principal lean techniques actualized. According to the case study, interferences for executing lean production that were referenced included:

- Confrontation to move both shop floor management and employees.
- Floor workers are hesitant to offer recommendations for upgrades.
- Disconnection among sales, marketing and product improvement.
- Floor workers are not native English speakers, so multilingual training should be done.
- Mindset that since machines in textile industries belongs such a huge investment, the machines ought to be running continuously.

Change of culture of the organization was the most examined interference. Organizations required best administrative responsibility to begin with the activities. The majority of the lean activities included the floor work force and they should have all been engaged in effectively. Lean activities were chosen at first to give some early achievement (George et al., 2011) The advantages of executing lean techniques that were referenced included:

- Lean makes the lot sizes smaller.
- Reduces the complexity of products
- Reduces inventory, Inventory reduced by half in one company.
- Decreases the amount of raw materials.
- Decreases finished product stock.
- Decreases changeover time. In one case its 45 minutes to 1.5 days.
- Increased production. In one case production increased 16% in one month after introducing 5s.
- Vacate space for improved business and expanded production.
- Decreases in production time.

Concerns were communicated that a portion of the advantages probably won't be seen for a considerable length of time or even years. Case studies of three companies in US are summarized as follows.

Case Organization A – 5S

This organization delivers a wide range of things from fabrics to denim, with abilities to offer full bundle by carrying out spinning, cutting, warping and weaving. The organization acquainted the

idea of 5s with their workforce by means of a counseling firm, which works with organizations to advance industrial improvement. In one specific unit of the organization's plants, the activities were creating multiple times more waste than the target. Manufacturing in the division was ceased for three days for the initial episode. The organization stopped generation around there to demonstrate their promise to the activity, since they needed everybody to pay attention to the event. Everybody working in the area appeared for the event and there was a sum of around 30 individuals. The initial step was to deal with the messiness from tables and workstations and gear to expel things not fundamental to run the procedure smoothly and any unneeded tools. They utilized the red label strategy to isolate these things from the customary production unit. The subsequent stage was to set areas and points of confinement for hardware and product inventory utilizing labels and indicators. Indicators, for example, distinguishing proof signs and lines were additionally set to demarcate pathways and the diverse stock regions. For instance, stock areas of void shafts were separated with lines on the floor, which not just recognized to the specialist where to store these things, yet in addition gave an utmost to what number of shafts could be stored (George et al., 2011).

Machines and tools to be utilized regularly throughout the workday were set and put away in the vicinity their purpose of utilization. It makes simple for employees to recover these things to utilize when required. Tidying up and sorting out the floor was an imperative objective that top administration had as a primary concern while leaving on this 5s event. The productive area and machines were given a decent cleaning to expel waste, grease and oil. The following stage was to guarantee that up to the mark working practices were set up and that everybody in the territory was prepared in 5s and comprehended the objectives of the organization. The key methods were recorded and promptly accessible for any employee who had an inquiry regarding his work. So as to support the upgrades made to the production unit where the 5s event had occurred, the organization utilized a 5s audit framework. This audit framework is utilized to guarantee that 5s is constantly completed inside the zone and that the systems and action sheets are kept up-to-date. Another imperative move made to support 5s was the weekly basis meeting set up after the three-day event. These meetups achieved recommendations for improving the procedure and workplace for the individuals. Previously, employees were hesitant to offer thoughts, however once a few thoughts were brought by the executives for consolation, the thoughts and ideas came at ease to the employees and floor workers. Meanwhile they started the meet-ups, more than thirty

recommendations for development activities have been submitted and affirmed. These recommendations were given precedence by the managers. The proposals could be given high, medium or low importance. These recommendations were recorded and put on an activity sheet that would get up-to-date as the projects were proximal to culmination. Activities could have a standing of either under scrutiny, draft, concurred or finished. Organization have seen the decrease of waste even further than their desires and objectives, because of the 5s program. Subsequently, the decrease of waste was slow and took more than a half year to produce results. Another advantage of the 5s weekly basis meeting was a more prominent familiarity with the effect of waste among the workers. Administration started contending to have minimal amount of waste in the floor. The organization designs to proceed with the worker meetups, however, has reduced to fortnightly meetings because of this being a moderate season. This organization has satisfied with the accomplishment of 5s in that division and might want to execute the program in different parts of the plant also (George et al., 2011).

Case Organization B – 5S

This organization is an expansive maker of a different collection of yarn types for product utilization. At this organization, the ambition for lean execution originated from corporates. The organization initially actualized 5s in its plants after two managers went to a 5s course. It utilized the assistance of a local expert, during the program had developed. The organization started by building up a 5s initialing and training project which moved from one plant to another inside the organization. The 5s groups were built up at the plants, yet a definitive objective is to have each representative trained in 5s. Most plants in the organization have present day computerization with couple of employees. Thus, it was not doable to pull individuals off their employments for exceptionally significant time to complete 5s. Therefore, the workers on the 5s groups would be relied upon to finish their program while on duty. One key part of this was proprietorship that is somebody needed to assume liability for the proposed project and that individuals turned into the facilitator for that lean group. The same vision of the plant supervisors and training facilitators had empowered the 5s execution to be successful. The organization actualized 5s with every one of the means as organization A did. Organization B did not pull workers of their duties for extensive stretches of time or bring employees of move for a project. The 5s organizer showed the 5s

framework to the groups, however the obligation of the project was put on the facilitator for that group (George et al., 2011).

This case includes 5s usage at a specific plant, which dissimilar to the other cases was not done on a zone in charge of product processing, yet a machine room. This case further embodies the way that a 5s program can be utilized anyplace. The degree that the 5s facilitator in this venture had executed the 5s framework in the machine room at this organization was astounding. Organization B did not utilize the 5s event framework, rather they trained the employees 5s in a short classroom set-up provided with necessary literature then expected the 5s facilitator and the employees to take responsibility for the event. The 5s coordinator uncovered that group and facilitator choice was the key for this set-up of 5s execution to work. A manager or specialist in the zone of the project was normally picked as the facilitator. The groups required the correct combination of individuals, some working in the area and some who did not, on the grounds that occasionally those not working in the subjected area could bring new and diverse thoughts. The 5s projects for organization B have taken a 'piecemeal' approach, where a little is done at once. The plant machine room investigated for this case has no exemption.

The facilitator of 5s project, who gave the tour through the plant and machine room, clarified that the project had taken a long time to accomplish. What made the machine room at this specific organization so noteworthy was the detail which had been labelled each part. Every cupboard and cabinet in the machine room was marked with a visual sign and a content description of the machine stored with the belongings. On every part of the cabinet was a symbol and content description of the part contained inside the cabinet. On the highest point of every cabinet was an inventory of all of parts stored inside holding their depiction, position and reorder data. To keep top of the cupboards, clear of messiness, the surfaces were not level but rather inclined. In this manner, anything put on top would slip off. To store different belts required in machines there are hooks in the wall. To guarantee that the correct belt was put away on the correct definitive hook, there were layout illustrations of the belts on walls with the content descriptions of the belts over the hooks. The organization saves in hundred thousand only by investing hundreds of dollars in 5s. The 5s project in the instrument room for this case study has wiped out the misuse of requesting a machine parts as previously in stock, since every one of the parts and devices would now be able to be effectively found. In this 5s project the facilitator in the instrument room trusted that this

project would spare this organization more than 40,000 dollars throughout the following year in device and part substitution costs (George et al., 2011).

Case Organization C – Value stream mapping

Organization C is a small textile factory, delivering knit and woven fabrics with less than 150 workers. The organization C arranged three days, 8 hours a day training activity on value stream mapping (VSM). Seven managers and workers including Chief Financial officer (CFO), plant engineer, plant manager, production manager, customer service manager of the organization taken part in the occasion. The movement was encouraged by lean specialist from the counseling group whom the organization is seeking help with training in their primary lean program executions.

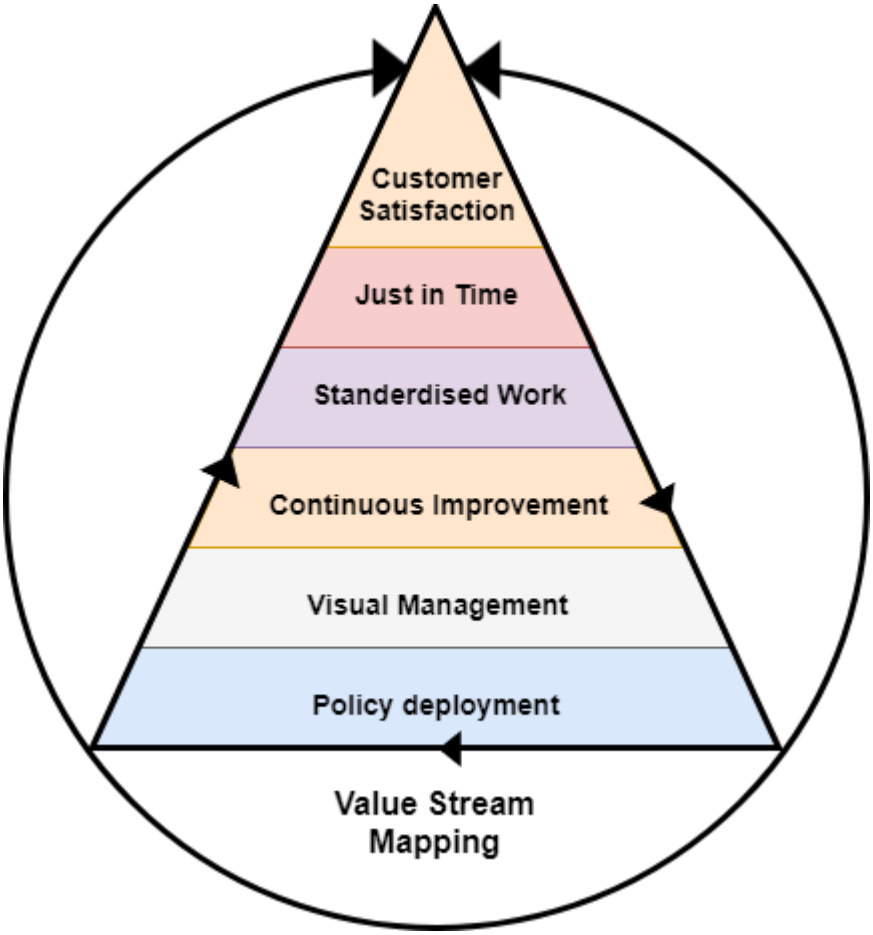

Figure 14. Lean implementation model. (Modified from George et al., 2011)

In the training session, the facilitator concisely disclosed lean assembling to the participating team, and the sorts of waste with the ideas of value added, non-value added. The training also clarified the reason for value stream mapping and the team experienced the state map of an imaginary organization together. After that the group started dealing with the organization's present state map. The initial step was to settle on which product or group of products ought to be mapped. The first group of products picked which was produced in high volume. After the group had settled on the product, the takt was determined dependent on a 4-week conjecture from the client. The group at that point separated into two teams, one to accumulate data to make the data stream and the other to gather the process duration, changeover time, cycle time and machine use rate. The second team also up to measure the stock time between each procedure of the product's value stream. At that point each procedure in the material stream was drawn out for everybody in the team to see and concur with, alongside each progression reported in the data stream. Then everybody had conceded to the material and data stream of the map. After that the facilitator demonstrated the teams how they could compute their lead time in days between each production process by separating the sum in stock by the takt. Additionally, clarified that the value-added time was the process duration or cycle time or the time that was spent at each process really in a product unit. In organization C's case one unit would be 1 yard of product (George et al., 2011).

The measured lead times amid every process were then adjoined to obtain the production lead time. To obtain the value-added time, the process durations or cycle times at every process were adjoined. By taking the proportion of value-added time with production lead time, the percent value added was then determined. Percent value added of the Organization C for this product was under one percent. The team identifies and planning a lean stream, Kanban, markets and push versus pull theory to actualize the future state map model, and how it can decrease lead time and increment the percent of value-added time. The team conceptualized the thoughts to improve their procedure, which would move toward becoming kaizen bursts later on state map. One of the real developments settled on by the team was to diminish the desk work from production control. There were also three changed reports that would be removed later on state alongside two electronic planning communication system. Later on, express, the planned schedule is just sent to delivery. At the point when the stock in the market achieves a specific point, a Kanban signal will plan the manufacture at the lower stream procedures Kaizen bursts upcoming state map which aim development in product flow involving making just-in-time warps, hence loom could be devoted

to one product and making persistent move through weaving (George et al., 2011). The more kaizen bursts are related with repairing and fixing machines and tools. These thoughts and ideas for improving the procedure were organized and used at the planning of kaizen event.

4.2.3. Case Study 3: Comfit Composite Knit Ltd

Comfit Composite Knit Ltd dated back to the year 2005 is equipped with the state-of-the-art machineries including backward processes that is Knitting, Dying, Garmenting accompanied with a well-tuned design and development team. Comfit is a continuous supplier to some retail giants of Europe like H&M, ZARA and C&A. Current capacity is 40 million pcs readymade garment per year with 35 ton per day fabric production capability as backward arrangement. Comfit Composite Knit Ltd employs around 15000 workers in their production system. The data presented in this section collected directly from field, that makes this primary or firsthand data.

As an action of practicing six sigma the organization applied lean to reduce the production waste of skip stitch, oil spot and dirty spot in a time frame of January to August 2017.After finding the causes of the specific wasted part they come up with solution to every issues creates the skip stitch, oil and dirty spots. Causes and their respective solutions of these problems are depicting in respective numbers.

Oil Spot

- **Root Causes**

1. Lack of defined replacement frequency for Oil seal
2. Sewing machine & working table not properly clean
3. Lack of adherence to defined cleaning process
4. Running body kept on unused / idle machine
5. Lack of adherence to defined covering process during maintenance

- **Solution**

1. Check the condition of oil seal in every sewing machine within 45 days.
2. Prepare guidance for cleaning sewing machine & working table
3. Prepare guidance for cleaning Sewing Machine.
4. No Garments body should be placed on idle machine
5. Prepare guidance for covering garments body during maintenance

Dirty Spot

- **Root Causes**

1. Running body kept on unused / idle machine
2. Use of Dirty Shoes on Floor
3. Lack of Cleaning of Floor in timely manner
4. Taking meal/tiffin at the workplace
5. Hand not wash properly
6. Input/ outside print embroidery body are not properly covered.
7. Uncovered running goods after end of the day work
8. Cutting input stock are not covered.
9. Uncovered running goods during machine cleaning by operator

- **Solution**

1. Separate idle machine from running m/c
2. Prepare guidance for using shoe in floor
3. Prepare guidance for cleaning the floor
4. Prepare guidance for taking food in shop floor
5. Prepare guidance for hand cleaning
6. Establish covered procedure of cutting parts
7. Prepare guidance for covering running goods after end of the day work
8. Establish covered procedure & color-wise stock of cutting parts
9. Covered running goods during machine cleaning by operator

Skip Stitch

- **Root Causes**

1. Improper adjustment of hook with needle
2. Process & Responsibility of Needle Setting not defined
3. Process, Criteria & Responsibility of Needle Selection not defined
4. Needle bend
5. Process & Responsibility of Thread tension setting not defined
6. Lack of defined speed for type of Fabric & Needle
7. Undefined quality of thread for applicable process

- **Solutions**

1. Proper checking after adjustment of hook with needle
2. Develop SOP for Setting needle and train operators for needle setting
3. Define SOP for needle selection & accountability
4. Define life time of needle & relation between needle size & fabric type
5. Define thread tension setting & accountability
6. Define machine speed according to fabric type & needle size
7. Establish Standard Quality parameters and perform Thread quality check before use

Implementation of these solutions over the problems shows up by improvements in reduced waste by dirty spot, oily spot and skipped stitch.

5. Data Analysis and Discussion

The level of leanness of an organization can be estimated by the utilization of different lean practices. All of the each of the organizations in case studies professed to have broad lean practices in their textile plants. Studies show that the reviewed organizations have distinctive perception of lean. The organizations modified the lean as indicated by their way of culture and assets bringing about various diverse elucidations of lean. Maybe for the ownership of progress is required, yet the principal vision must not be changed, and the elucidation of the rationality must not contrast from the proposed importance. In this study the apparent outcomes and the findings were not the equivalent. The study was organized so that discloses to what degree the organizations are applying diverse lean techniques. The primary arrangement of study was general in nature and looked for data with respect to the act of different lean instruments and accomplishment of results as well as the factors affecting lean in textile industries. This shows the dimension of comprehension about lean theory. It creates the impression that the comprehension of the organizations can be interpreted as a boundary to lean implementation and in some of them they had misconstrued certain parts of the lean techniques. This section proceeds to discuss the case studies and investigating the likenesses and contrasts between the execution of lean in textile industries Bangladesh and past endeavors of other essential activities. The textile industries also need to build up a scheduled plan so as to increase consciousness to accomplish further enhancements throughout lean implementation.

5.1. Extent of Lean Production Practices

Effective lean execution relies on different matters and in different extent. From the study its uncovered that a few textile industries started lean usage from the earliest point of the beginning of generation in their plants, while others began lean execution following a couple of years from the time of foundation. The discoveries propose that since the industries have been seen effective in diminishing expense and improving profitability, it isn't the period of time of practices, yet rather the adequacy of execution that decides the accomplishment of lean usage. Regardless of the legitimate status, for example, private, worldwide joint venture or public, the organizations accomplished improvement in efficiency and execution. In this way, there is no immediate effect of lawful status of organizations on production success or any authoritative projects like lean

generation. Most of the organizations had group-based structures and the rest of the organizations had functional structures. This is in high-pitched contrast with general idea that a group structure is fundamental for lean usage, or the successful execution of any sort of progress activity.

In spite of the fact that it is uncovered in the example that variety among the organizations with various hierarchical structure isn't an obstacle in lean execution, in the meantime it is demonstrated that top administration of the organizations does not know about the way that a useful structure confines adaptability. Although the fact that they are accomplishing comparable outcomes to the group-based organizations this keeps reconfiguring authoritative structure from the functional to a group based-structure. Whenever actualized accurately, lean gives a lot of visual administration strategies to effectively impart guidelines, show stock dimensions and procedure status and work proceedings.

An essential sign of lean production is a supplier or provider base. Most of the industries were reliant on a vast provider base which is as opposed to the lean practice basics. Although the majority of the industries plan to keep up long term association with providers, keeping up long and stable associations with such a vast provider base is tough. Having a lot of providers and not lessening the number, even after a significant time after lean execution requires a long-term technique to reduce provider numbers. Therefore, acknowledge more advantages, for example a long-term association with providers through cooperative risk, cost and data sharing.

The observed industries had embraced a vast assortment of lean tools and methods, for example, Kanban, Kaizen, JIT, Pull production, 5S, TPM, VSM and so forth. Just in time and pull production framework are two vital practices of lean. The essential focal point of JIT concentrates on a force approach whereby production exercises of one stage are connected and constrained by the exercises of the following stage. As a rule, a Kanban framework leads the signal starting with one stage then onto the next because of a requirement for service or product. All of the organizations had both a Just in time and pull production framework yet some of the organizations had Kanban practices. Organizations without Kanban were utilizing verbal directions instead of the Kanban. This verbal direction may cause noisy condition, instability and conceivable miscommunication. In the event that these organizations host a progressively organized visual device like Kanban framework, it could make lean increasingly effective. Just in time framework is a crucial component of lean production. All of the organizations have Just in time frameworks and in case

of Bangladesh the textile industries provider is exceptionally trustworthy as far as regular and auspicious delivery of materials.

Nonetheless, the importation of materials can't fall under just in time, as JIT implies delivering the perfect amount of product at the opportune time to the correct spot so as to lessen the stock. The Bangladeshi textile industries were found to have a just in time framework while getting supplies of raw materials from the nearby providers. On account of foreign imported materials, the organizations had a delivery time of two months. This enabled the industries to create accessibility of items in the JIT procedure.

One of the fundamental and basic practice of lean is Kaizen. Most of organizations have been practicing ceaseless improvement or Kaizen and have improved quality in the structure of their items. As a measure of the improvement procedure the organizations revealed about the recommendations conspire, worker inclusion, reward to workers, unconstrained critical thinking, administrative input to workforce in a convenient manner and so on. The recommendations were profoundly energized and executed by the organizations with a view to ceaseless improvement. As lean is a client responsive production framework, on-time delivey and adherence to a daily based arranged timetable are important for the organizations to be responsive. All of the organizations can meet the regular production plan. However, in the current socio-social of and stable political circumstances of Bangladesh, textile industries can meet the calendar unfailingly unlike previous years of production. Also, the organizations had a few issues like transportation, and traffic clogs etc. which occasionally postpone the delivery procedure. Considering the present situation depicted above, adherence to the intended schedule is not so difficult now.

It requires significant consideration in lean production regarding the plan of machines and tools which incorporates machine format into production units and establishment of machines as indicated by just in time production stream in each textile production unit. Every one of the organizations aside from one had an appropriate plan of format for equipment either in U or V shape. Effective course of action of hardware lessened the requirement for plant facilities by driving down space required for production. The industries have all around kept up updated and modern equipment just as great material handling frameworks. From the case study, in case of US and India all organizations are using 5s, but in case of Bangladesh less than 50% of the organizations are utilizing 5S. But 5S is a fast and simple instrument during the time spent

ceaseless improvement of quality. When the studied organizations are utilizing other complex techniques for lean however not 5S, it demonstrates the absence of a genuine lean condition in the organizations. Normally if the organizations have sufficient learning and awareness with respect to lean techniques, they may initially acquaint the simple instruments with observe advantages and afterward progressively complicated strategies. A perfect and efficient work environment implies that organizations are utilizing 5S. This proposes why the organizations require an intensive comprehension about lean related techniques to guarantee achievement.

Most of the Bangladeshi textile industries of study practiced Total Productive Maintenance (TPM). Some of them have ordinary program of servicing and cleaning though regular servicing and cleaning does not mean the genuine TPM. TPM tries to connect all levels and activities in an organization to boost the general viability of production framework. Some industries yet need all the clearer comprehension with respect to this system to get the full advantages from it. The studied textile industries of Bangladesh have limited machine changeover time running from 20 minutes to 3 hours which is a significant decent accomplishment. The utilization of small lot sizes was underscored by all the organizations. However, there is no basic common meaning of lot size to the organizations. In spite of the fact that in lean manufacturing, small lot implies single piece stream, in the investigated organization of Bangladesh a small range from 10 to 20 pieces at any given moment. Despite the fact that the number of pieces were very high, this realignment significantly decreased the stock dimension and overproduction of the organizations. Small lot size likewise enabled the organizations to distinguish faulty items more rapidly than previously. All lean business needs an information management framework to connect every practice. The organizations from Bangladesh were utilizing their very own purchaser affirmed customized software. Some of them does not support lean framework rather it energizes push production framework as organizations acquired that software before execution of lean. As the substitution is a very expensive process, the organizations were not ready to change.

Lean is a customer responsive framework and profoundly centers around the decrease of delivery time. Delivering items on time to clients the organizations supposedly utilized a few lean tools, for example JIT, kaizen and Kanban, etc. It shows up from the information that by utilizing these tools organizations could essentially decrease the order to shipment process duration. This implies organizations can get more improvement from a completely thorough execution of lean. To

execute the lean practices, the organizations got specialized help along with training from consultant organizations, specialists. The training fundamentally on-work training with the goal that the workers can play out a wide range of jobs to be done, leadership development and so forth. For the total accomplishment and to endeavor and further sustainable developments, a completely extensive training program and an execution technique as per the individual organization's prerequisite are required.

5.2. Factors of Lean Implementation

A few factors have effects on the lean manufacturing framework in the studied textile industries. The present discussion distinguished various factors that helped the lean execution and furthermore a few factors that went about as obstructions to its usage. Yet, the positive factors different from organization to organization, reliant upon their individual distinctive culture and accessible assets for example, top administrative commitment, technical assistance trained staff and so forth. The supporting and impeding factors are introduced underneath. The organizations were encouraged in lean execution by a decent number of supporting factors.

1. Training is the most important supporting factor reviewed in the organizations. The Indian and US textile industries reviewed got training from third party consultants and specialized personnel and in Bangladesh it’s from BGMEA - the umbrella organization depended with the general welfare of the textile processing textile plants in Bangladesh. For lean implementation training is a minimum necessity and for effective usage of any of the lean systems. Trainings concerning primarily about on-job training which accentuates hypothetical training in performing different sorts of projects along the production procedure, leadership ability training to receive accountability for teamwork and improvement program of awareness in lean related issues.
2. Positive employee attitude assumed a huge job in lean execution. Because of inspirational positive attitude, the employees did not raise any voice against its execution in the industries. Both in the group-based work environment in organizations and the progressive communication was of the utmost importance for this participation.
3. Commitment of management is another significant positive factor for lean implementation. It is another imperative empowering factor that is the best administrative

responsibility and support in their specific organizations. This dedication was unconstrained maybe due to the way that the administration could effectively welcome the weight of the competitive circumstances worldwide in the textile industries.

4. Mainly textile industries are seeking technical help and support form their own technical division or technical service firm, in Bangladesh they seek support from clients or parent organizations. Technical support is another empowering factor that enabling the organizations apprehensive about running the program of lean implementation. Technical support aided in the lean execution.
5. For certain industries client suggestions were another boost to actualize a lean framework. Giant clients, in Bangladesh particularly foreign clients to export, demanded a higher quality of items at a sensibly less expensive cost than the most significant contenders especially of South and Southeast Asia counting China.
6. A reasonable awareness among the administrative individuals in the organizations about the lean framework helped them level continue with lean implementation. This implies preparing had to do a noteworthy job in the expansion of awareness.

Generally, textile industries were encountering obstacles to some degree in the usage of lean. Nevertheless, the supporting components talked about above, various impedances additionally experienced by the organizations.

It is evident that in this change program most of the studied textile industries face obstruction from various section inside the organization. Employee confrontation is one of the most impeding factors in Bangladesh. 2% of the reviewed industries of Bangladesh encountered no obstruction, the rest of the organizations confronted opposition primarily by the middle administrations and lower level supervisors. This obstruction was because of the absence of sufficient learning about new framework. Sometimes outside competitors motivated the trained employee from the organizations by offering alluring advantages and different facilities. This relocation of trained employee is a genuine impediment to lean execution as the organizations are failed to keep up a minimum amounts of trained workforce to create and continue new thoughts and they also have to train new group of employees. Traffic and transportation issues are most important hindrances in lean manufacturing as JIT depends mostly on it. Who have their own transportation system of action, have no vehicle issues? Organizations have some vehicle issues who uses third party

vehicular system. Organizations of Bangladesh have concerned about issues with port for foreign shipment. Generally, those who utilize the city roads for shipment, face high traffic issue and in this manner problematic delivery times. To meet their daily plan these organizations had to utilizing substitute routes. Although the majority of the organizations have their very own power generator plan, the power supply issue is so visit in the case of Bangladesh. Marginally half of the reviewed organizations of the Bangladesh faced the unfriendly effect of intensity supply issues as diminished efficiency and expanded cost. Inadequate learning among certain representatives brought about misguided judgment and error of the essential importance of lean. Absence of training is the way to this issue. In Bangladesh political situation and legislative processes increase the product lead time, creates the vulnerability of regular collection of raw materials just as convenient delivery of order. These enormously impede the lean achievement. The following figure provide the overall benefits, some important impeding factors as well as supporting factors of Bangladeshi textile industries.

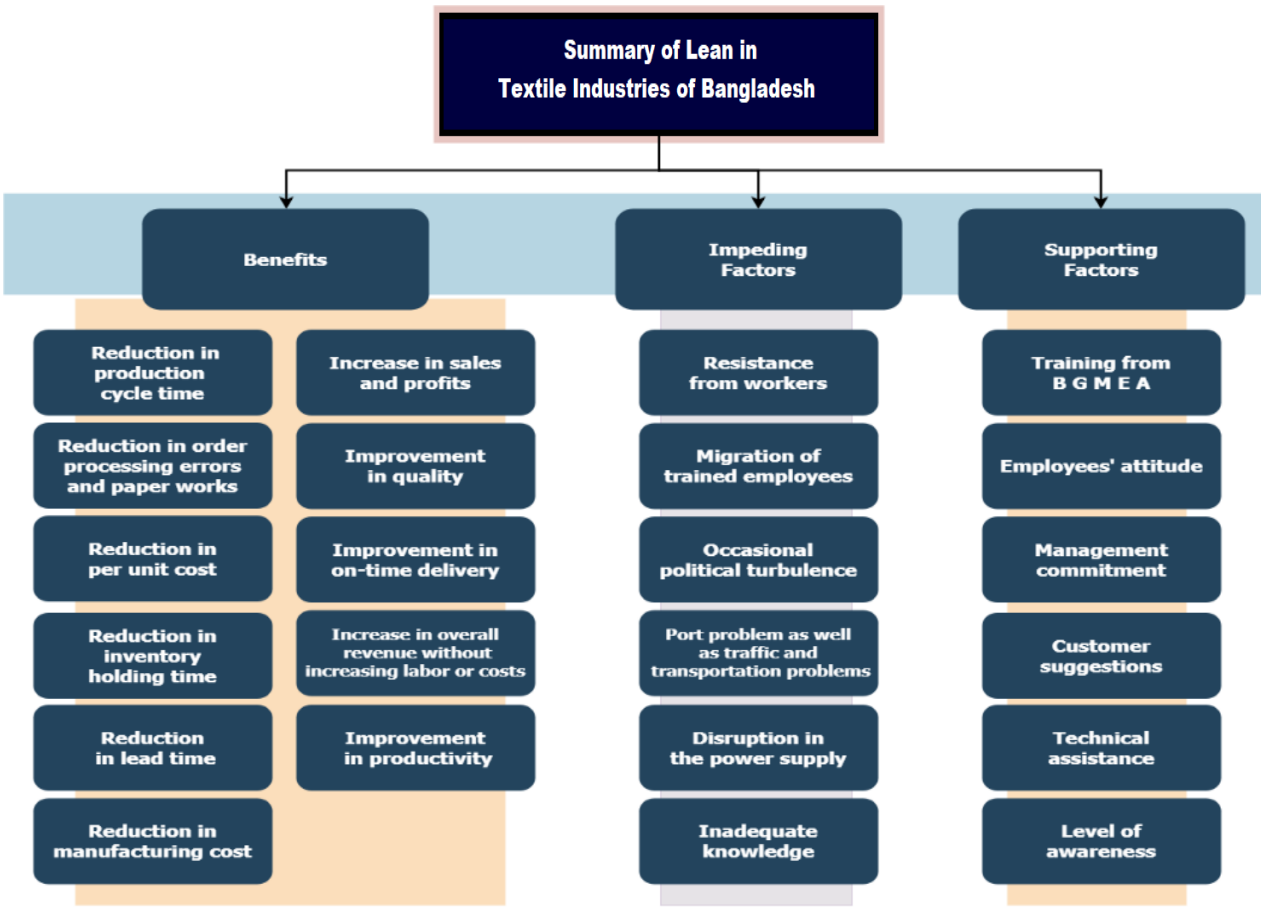

Figure 15. Outline of Benefits, impeding and supporting factors related to lean implementation in the Surveyed Bangladeshi organizations. (Modified from Ferdousi, 2009).

5.3. Benefits resulting from Lean implementation

All studied textile industries want the advantages produced by the support of lean production in their business. Studied organizations inferred benefits out of lean practices in terms of expanded sales and profitability, reduced processing faults, increased paperless work, reduced production costs, lessened employee stress and expanded income without expanding work or overhead expenses.

By practicing a few lean tools, the organizations demonstrated a general improvement in production performance. The accomplishment in manufacturing cost decrease was through an expansion in the quantity of units of items with same labor along with decrease in stock which contrasted with the pre-lean period. The study shows improvement in profitability and productivity

in organizations. Long lead times show wastefulness of the manufacturing processes. The shorter the lead time, the more receptive the organization and better the order fulfillment of clients. The organizations accomplished such improvement in lead time by adjusting their machines in a strategic way, lessening movement time of the employees and forestalling continuous and unexpected machine interruptions through a program of TPM. The higher the improvement in process duration the higher the improvement to the organization as far as more unit manufacture. This improvement in cycle time carried more consumer loyalty with quick delivery and furthermore opens scope for receiving more requests from new customers. The following figure shows the improvement situation how the implementation of lean decreases the order to ship cycle time.

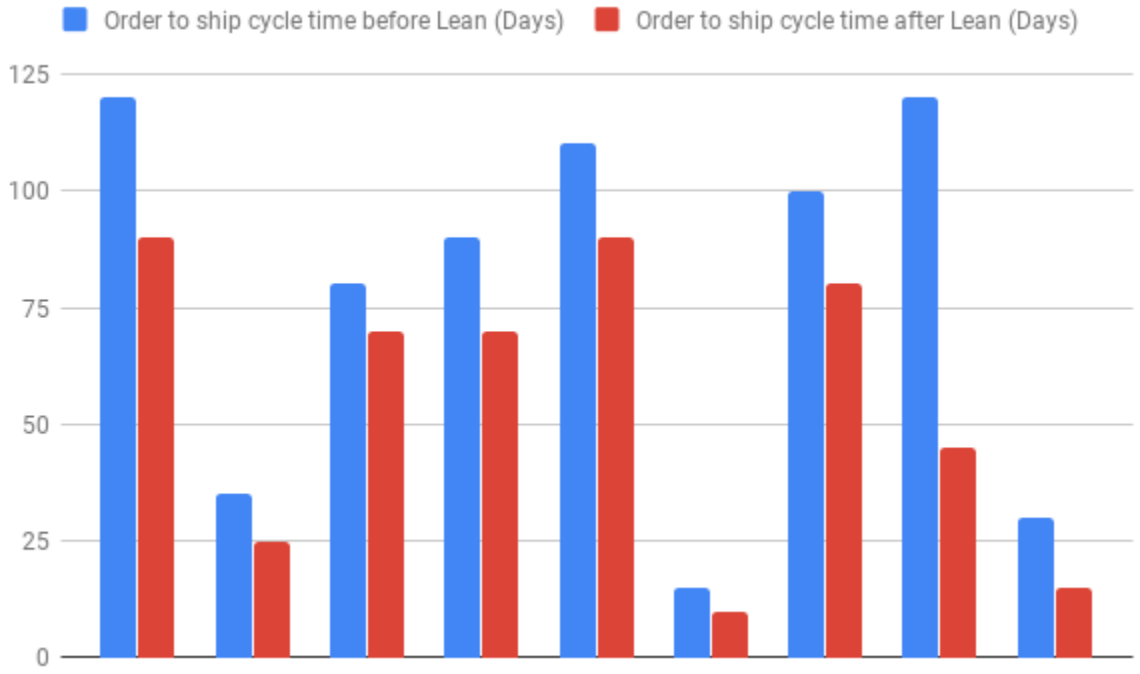

Figure 16. Just in time relationship with customer.

The garment industries accomplished a significant improvement regarding decreasing the quantity of long stretches of stock. This was conceivable, through expanding correspondence, building up provider's relationship, training of providers, JIT delivery of completed products, the utilization of specific database and working feedback frameworks. Maintaining high and steady product quality is a key component of sustaining in competitive market. The study demonstrated that the majority of the organizations had considerable improvement in quality while reducing the waste and cost.

The following figure indicates the average inventory time which is decreasing after implementing the lean.

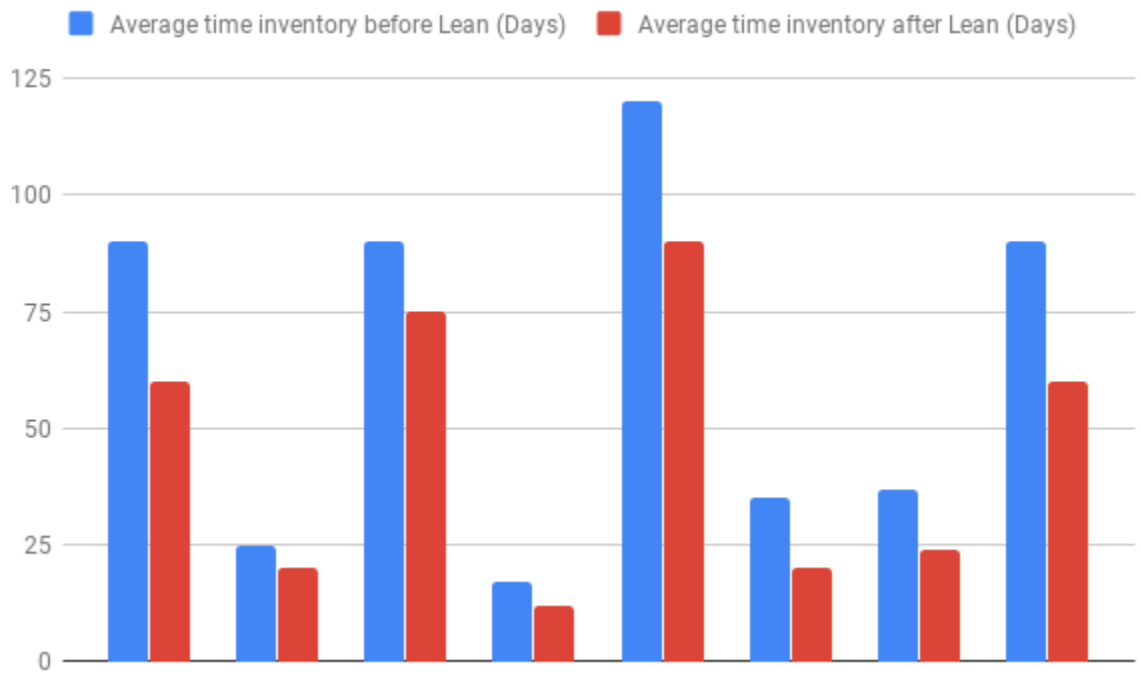

Figure 17. Average days of inventory before and after lean in the studying industries.

The fundamental focal point of lean production is to reduce a few kinds of waste from the production procedure. Every one of the organizations decreased the waste brought about by overproduction through after make according to order methodology which implies organizations will go on production of item just when they get order from the client. In addition, the organizations decreased the stock through Just in time delivery system, trained employees just as great provider relationship. The result showed a critical decrease of all forms of wastes however there is still chance for more increases in reduction.

By practicing six sigma applied lean to reduce the production waste of skip stitch, oil spot and dirty spot in a time frame of January to August 2017 in the case of Comfit Composite Knit Ltd. they come up with solution to every issues creates the skip stitch, oil and dirty spots. Implementation of these solutions over the problems shows up by improvements in reduced waste by dirty spot, oily spot and skipped stitch, which lead to reduction in wastes created by skip stitch, oil and dirty spots.

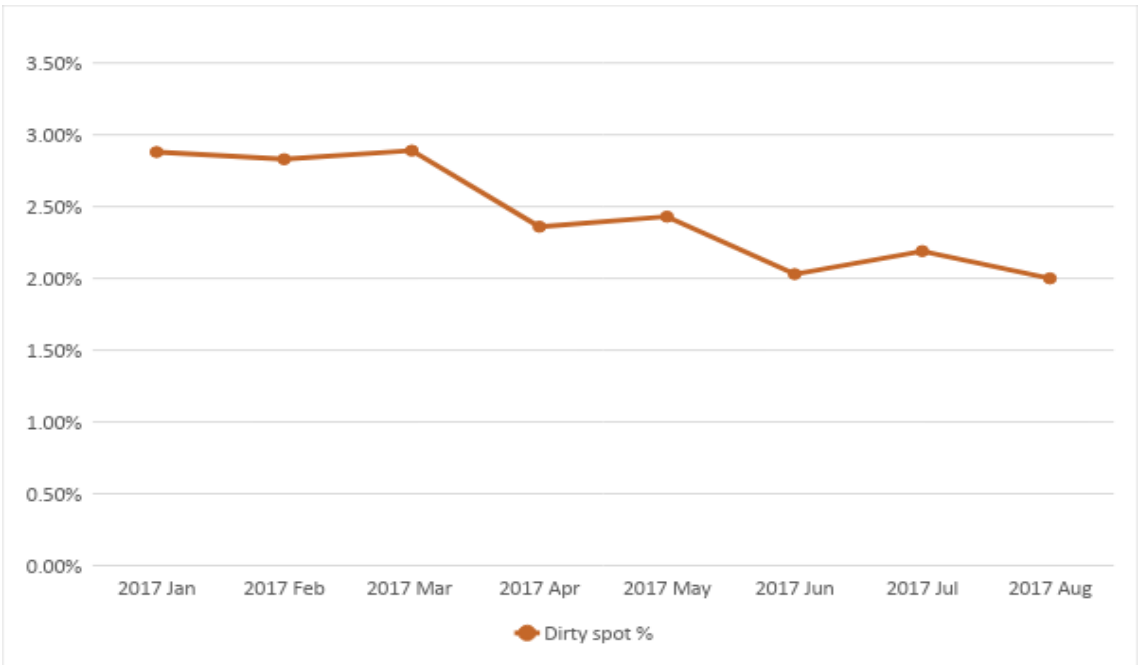

Figure 18. Percent dirty spots in the production of Comfit Composite Knit Ltd. from January 2017 to August 2017

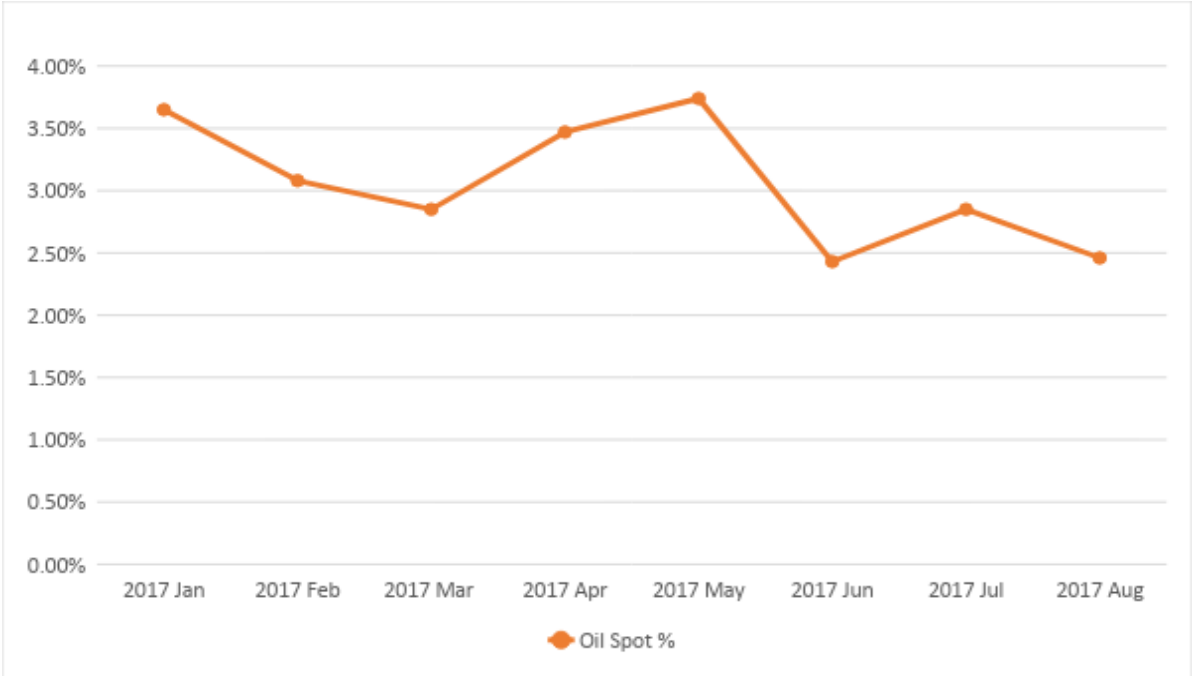

Figure 19. Percent Oil spots in the production of Comfit Composite Knit Ltd. from January 2017 to August 2017

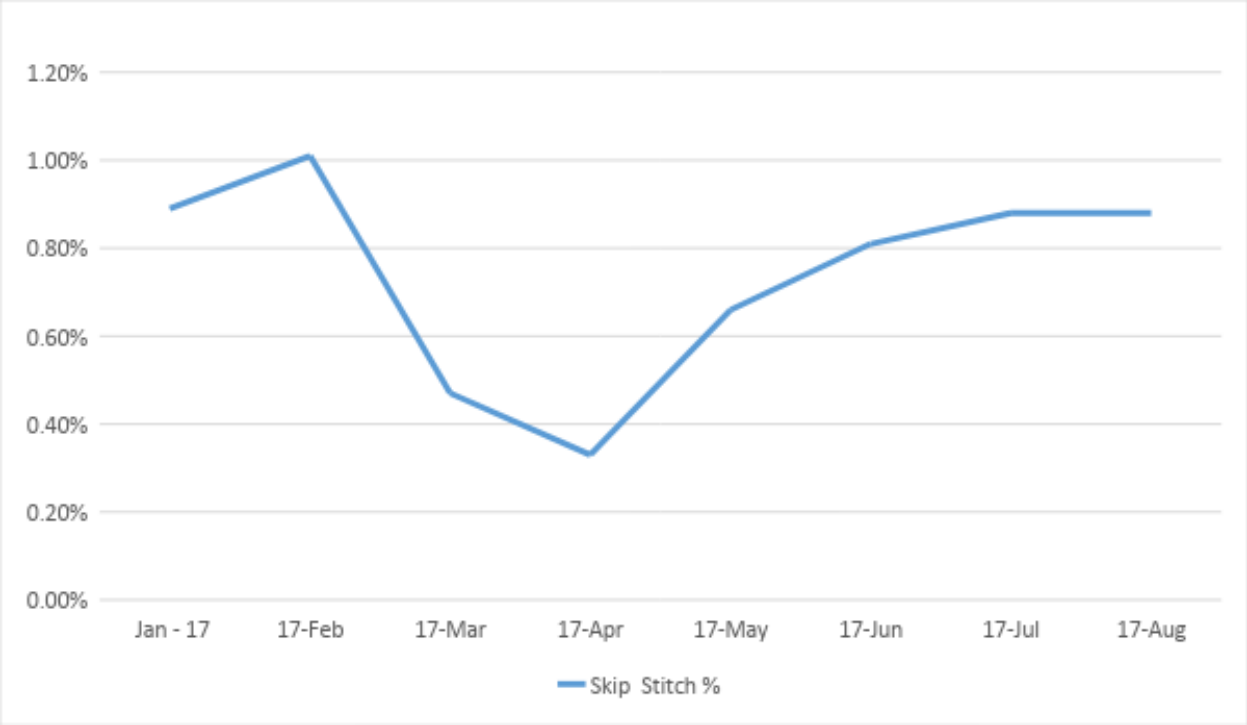

Figure 20. Percent skip stitch in the production of Comfit Composite Knit Ltd. from January 2017 to August 2017

The organization saves from oil spot in one month as 250 USD worth in one production unit. This company have also saved 55 USD in one month from one production unit. Which in turn makes a total potential savings of 36,600 USD over the year in all production units by solving oil spots and dirty spots.

5.4. Future recommendations

The future recommendations intend to make lean progressively productive. All of the organizations have plans with respect to the future improvement. Organizations are commonly present other lean practices notwithstanding the current practices just as including knowledge sharing and training programs for the providers and wholesalers other than the employees. Still, the current practices are uncertain to some of the organizations. They have a few confusions and misinterpretations with respect to these issues. This proposes, before moving to other new practices they ought to rather introduce broad learning program. In Bangladesh in comparison to others the

majority of the overviewed organizations are utilizing different lean techniques to some degree yet are not really on the way to accomplishing absolutely complete lean production framework. They did not find the reasoning appropriately because of the absence of legitimate information and awareness. This recommends a careful comprehension with respect to the techniques for lean production which requires a successful preparing program for administrators, specialists just as providers is required. The joined learning of different gatherings can help in the effective usage of lean. Maybe the following stage for these organizations is take a gaze at their structure and change this after some time to be progressively lined up with a lean methodology. For further improvement the organizations may make the accompanying steps:

The organizations need to expand the ability dimension of the execution group through training in the different lean techniques. For this an operator can be presented. This operator might be an outside specialist or interior staff who can instruct workers and increase the vitality to drive these progressions through. A basic component of achievement in lean execution is acquiring the administrative responsibility and worker contribution through steady correspondence. Senior administration needs to impart plan and vision to the workforce. To make a genuine bond, the quantity of providers ought to be reduce to a base dimension. This should be possible through an appropriate survey of the current providers and afterward recognize the best. The textile industries are probably going to be extraordinarily profited as far as effective usage of lean on the off chance that they create organization with the lean advertisers to create and change lean techniques, guides, training and gathering sessions to address lean implementation.

The reality that the comprehension of the authorities of the organizations of the lean problems can be interpreted as an obstruction to lean execution recommends the requirement for building up an activity plan with respect to the organizations to increase the dimension of awareness of the authorities to accomplish further upgrades amid lean execution. The organizations need to urge the providers to include lean in the manufacturing procedure to guarantee anticipated quality at a lower cost.

5.5. Comparison of the Results

The consequences of the present investigation will be contrasted with the comparable examinations comprehensively to feature the positive relationship of the outcomes. This affiliation can give a view to whether the Bangladeshi organizations are encountering comparative limitations, empowering agents and results to past comparative endeavors. A small knitwear producer concentrated on how dynamic execution of Just in time (JIT) can get upgrade its performance. It was a New Zealand based organization delivering around 90,000 pieces of clothing for every year. The organization creates a broad item go which is regular in nature and every year updated concerning styles, yarn, designs and color. The organization experienced a few issues because of the conventional production theory and perceived abnormal amounts of stock, long lead time, poor correspondence and conventional design. The reviewed textile producers of this study likewise experienced comparable kind of issues, for example, long lead-time, long stock holding time, several kinds of high amount of wastes and long conveyance times. High challenge and pressure from various sources, for example, parent organization, issued from buyer organizations, drove the reviewed organizations to present lean. In the examination by Mazany (1995), the underlying targets of the organization were to lessen lead time and stock dimensions by half with no trade off in quality. These goals were drawn closer through three stages.

Through steady integration of kaizen, multi-talented and group-based approach, the organization decreased the lead time from 10 weeks to about a month and expanded worker association from 5 to 30 percent. The organizations additionally presented a few lean devices, for example, JIT, 5S, TPM, kaizen, pull production, and attained a few advantages. These organizations decreased lead-time, stock holding time, producing process duration and so forth contrasted with pre-lean period. In general, the organizations picked up progress in efficiency and quality, stock holding time by 30.1%, decrease in lead time by 26.7%, producing process duration by 26.1% and moreover reduced the delivery time. The best gained, organization acquired a reduction by half in lead-time which is predictable with this situation. While the organizations acquainted lean production to defeat the issues, the organization also introduced JIT. Just in time is a basic component of lean manufacturing. This shows in both the studies the organizations utilized various comparative devices and experienced numerous comparative enhancements. So, it is evident that not everything rather the supporting and impeding factors were likewise same in most of the cases. Awareness and quality circle of workers are basic in both the cases. In both of the cases, the impeding factors

demonstrated similitudes, for example acceptance, the administrative approach, organizational culture, conventional imperious nature, social hindrances etc.

The success of implementing lean have a positive relationship with different examinations utilizing comparative rationalities. The majority of the organizations under correlation are either readymade garment or textile industries. Distinctive methodologies, for example, lean, JIT and so on were utilized by the organizations took account it, to take care of the comparative kinds of issues. These methods of insight have normal attributes, for example, group-based work, employee association, significance of administration, cultural change etc. From this study Bangladeshi organizations can take initials as these organizations can possibly execute similar lean learnings from other countries that because of these normal attributes lean as well is also similar. It is beyond imagination to expect to measure the critical improvement in these organizations in light of the fact that the studies were directed under various authoritative settings and conditions. As found in the correlation of the results of the present studies, the better enhancements can occur in the Bangladeshi organization like other organizations who are up to implementation of lean. In any case, this requires the correct condition. In the event that the study Bangladeshi organizations can accomplish further execution improvement, at that point other textile organizations of Bangladesh can likewise get the equivalent by giving the correct condition. It is vital to make the suitable environment and training for all projects to understand these upgrades.

6. Conclusion

Lean practices can make the manufacturing activities speedier and less wasteful in the industry. As of late, Bangladeshi textile industries have begun implementing 'lean manufacturing'. The most vital undertaking for the textile industry is to lessen the lead time which is likewise essential for long-term improvement to stay competitive in the worldwide market. A fast race to decrease lead time by lean has made direness for researchers and industries to apply new tool and procedures for wastages. As textile industries in Bangladesh is trying to implement a wide assortment of lean techniques and systems despite the fact that the implementers do not have the adequate knowledge of the lean features of these tools and strategies. They have inferred a few advantages including improved production performances from lean practices that have helped them accomplish improvement in the business. Lean execution in these textile industries was encouraged by a few supporting factors, although there is some impeding factor as well. The organizations under investigation have empowering suitable ambience for effective lean usage. There has a huge scope of that selected Bangladeshi organizations can accomplish performance improvement like other textile industries in various countries.

Like most other thesis work, this work has also some limitations. In this study- The lean practices have investigated only in some mode case industries which is not adequate for observing the situation and measuring the output of lean practices in textile industry of Bangladesh. This thesis was conducted based on the secondary data and observation obtained from the open sources and did not find any real data from the industries.

6.1. Further Research

This thesis work provides a clear picture of different lean tools and their implementation in textile industries. In this work there has only nine Bangladeshi textile industry is taken to analysis, but as a future research, more industries are needed for a more comprehensive study and as well as to analysis the current production processes, finding the improvement way where lean concept can be implemented and making the continuous improvement by implementing the lean tools. In the Comparative case studies section, there has only considered three countries as a comparative case study analysis- India, USA, Bangladesh. In further study, more other countries where lean is practicing need to be analyzed and compared with Bangladeshi textile industries and propose the

different improvement way for practicing lean in textile industry of Bangladesh. When implementing lean tools in Bangladeshi textile industry there has found some hinders factors, In the future study need to find out more supporting factors along with the current supporting factors so that lean can be implemented widely in textile industries of Bangladesh.

7. References

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