Practice of Lean Manufacturing with its Effect in Supply Chain Performances in Bangladesh Readymade Garments

AHM Yeaseen Chowdhury¹
Md Zahedul Alam²
Md. Ali Aksad Rupaul³

Abstract

The export-oriented apparel industry of Bangladesh, popularly known as readymade garment (RMG) occupies a unique position in the economy of Bangladesh. It is the largest exporting industry, which experienced a phenomenal growth during the last three decades. Thus this sector is playing a vital role in the socioeconomic development of the country. However, this sector is struggling with a number of problems including lower rate of efficiency, increased lead time, and maintaining rate of Right First Time (RFT), lack of standardized work method etc. Moreover, in Bangladesh, the sector is facing problems in manufacturing process which is ultimately reflected in higher cost of production. To be competitive in the market, companies must be efficient in the manufacturing process. Lean thinking came into light as an operational strategy that might help RMG sector to cope with these challenges. To find out the use of lean manufacturing philosophy, a market leading factory was studied. Firstly, the changes in work method and culture were identified, and then statistical analysis was conducted to compare the performance before and after lean practice. There is lack of research on the impact of lean practices on supply chain performance improvement in Bangladesh RMG industry. Efforts have been made to explore as to how a traditional factory converted its management and manufacturing concept to lean management practice and its impact on supply chain performance.

Key Words: Lean Manufacturing, Ready Made Garments (RMG), Supply Chain Management (SCM), Right First Time (RFT)

1 Introduction

The export-oriented apparel industry of Bangladesh, popularly known as readymade garment (RMG) or the garment industry occupies a dominant position in the economy of Bangladesh. It is the largest exporting industry, which experienced a phenomenal growth during the last three decades. This single sector alone earns about 80% of yearly foreign exchange of the country (Karim, et al., 2012). Since independence, no single sector could accelerate the industrialization process in the country comparing to what RMG sector could do. It has created employment opportunity for about 3.5 million people (Sarkar Hossain, 2011). Most of them were uneducated and unskilled. About 80% of them are women (Hasin Zahira, 2015). To a credible extent, it has been able to relieve the country from the burden of unemployment and at the same time contribute to the empowerment of women. Thus this sector is playing a vital role in the socioeconomic development of the country.

In today’s competitive business world, companies’ success primarily depends on the performance of the supply chain which ultimately adds value to the products. One of the elements of modern supply chain is ‘Lean Manufacturing’ which has been practiced in Japan for many years contributed to waste elimination, cost reduction and employee empowerment. The term ‘Lean’ as Womac and his colleagues (1994) define it as a system that utilizes less in term of all inputs, creates same output as those created by a traditional mass

¹ Associate Professor, Head of Department, Department of Finance & Banking, Faculty of Business Studies, email: yeaseenchy@yahoo.com
² Assistant Professor, Department of Marketing, Faculty of Business Studies, email: zaheddu@yahoo.com
³ Lean Management and Engineering Consultant, Dagher Consulting Group Pvt. Ltd. email: rupaulsust@yahoo.com
production system, while contributing increased varieties for the customer. Manufacturing sector is considered to be the major industry worldwide on which the development of the country depends.

However, this sector is struggling with a number of problems like lower rate of productivity & efficiency, higher lead time, higher cost of quality, lower rate of Right First Time (RFT), lack of standardize method of work etc. Besides, buyers are applying new fire, safety, compliance audits which add cost for factories putting factories are more challenging situation. However, RMG sector is taking new initiatives to run its operation in a better way. Practicing Lean Manufacturing is one of the solutions to overcome those limitations and prepare for upcoming challenges.

2 Objective of the Study
This research was about studying how lean manufacturing can be adopted to the discrete manufacturing system and evaluates benefits on supply chain performance. The objectives of this research are:

i) To discuss lean manufacturing in general and identify the changes adopted in lean manufacturing
ii) To measure the effects of lean practice in selected supply chain performances

3 Literature Review
In recent years, huge literatures have extensively documented the implementation of lean philosophy into various manufacturing sectors, but very few have addressed the garments environment. This is a Japanese concept applied in manufacturing firms. The Japanese firms including firms in other countries have been using this concept to reduce the cost of any process by removing waste. The basic elements of the concept include waste elimination, continuous one piece workflow (EPA, 2003) etc. Lean makes an organization more responsive to market trends, delivers products and services faster and produces products and services with less expense than non-lean organizations. As viewed by Womack & Jones (1994), firms in several industries in North America, Europe and Japan followed this path and doubled their performance through reduction of inventories, throughput time and errors.

Alukal and Manons (2002) argued that a planned implementation of lean production system leads to improved quality, better cash flow, increased sales, better productivity, improved morale and higher profits. They further reported that companies earned greater benefits by implementing lean techniques in the office functions in non-manufacturing organizations, too. A study on a Novartis International AG, a Switzerland-based company (Society of Manufacturing Engineers, 2007) reviewed their production process and realized the need for some improvement. They introduced lean picking system for the movement of the goods from the warehouse to the packing lines. This redesigned material supply is a kind of Kanban system. Through this picking system the company reduced its waste to a good extent. Moreover, studies have been undertaken to find out the relationship between lean practices and manufacturing performance of the firms (Papadopoulo and Ozbayrak, 2005). Bonavia (2006), Simpson et al., (1998), EPA, 2003; Oliver et al., (1993) also showed the improvement in manufacturing through lean practice. Chihuahua (Society of Manufacturing Engineers, 2007), the producer of world class power and signal distribution system of Mexico, reviewed its existing manufacturing system and identified the need for improvements in efficiency. The company introduced lean with a view to improve the current performance. It was documented from the study that implementation of lean brought 34% reduction in inventory over a 12 months period and 93.5% uptime.

The Bangladesh RMG industry has been facing tremendous competition from countries like China, Vietnam, Cambodia, Sri Land and India. “The increase in competition has led to an increased focus on customer
satisfaction as a survival of the company in the long run” (Kapuge and Smith, 2007). In today’s competitive business world, firms are fighting against each other to ensure their survival in the industry. The RMG industry is also searching for ways and techniques to cut cost and improve performance. When other industries are facing high pressure from competitors, the garment industry is also facing challenges in areas like price, delivery time and service offered etc. Mercado, (2007) argued that the garment industry has numerous opportunities for improvement using lean principles. Through the implementation of lean, the garment sector can reduce costs, as well as increase customer responsiveness through reducing several types of wastes from the production process. Customers demand quality products and on-time delivery. Lean practices can fulfill these requirements by reducing lead-time as well as manufacturing cycle time.

A few countries in the world already introduced lean tools in the garment industry and achieved tremendous improvement (Mazany, 1995; Bruce et al.; 2004). This practice improved their productivity, quality and lead-time and also made their customer more responsive. In addition to this, lean production involves, motivates and develops employee skills through education and multi-skilling program (Mazany, 1995). A recent case study on Indian shirt manufacturing factory evidenced high performance. Some of the key benefits entail production cycle time decrease, number of operators required to produce equal amount of garment is decreased, rework level reduced, production lead time comes down to one hour from two days (Neha Gupta et al., 2014). Another case study on Bangladeshi knit factory found that non-value added activities on Standard Allowed Minute (SAM) is 3.911 minutes where value added activity was 21.136 minutes. By eliminating non-value added activities, hourly output of selected line increased 18.50% (Mazedul et al., 2013). Another case study conducted by Karim et al. (2012) on a Bangladeshi RMG, suggests implementing 5s; Seiri (Sort), Seiton (Straighten), Seiso (Sweep and Clean), Seiketso (Systematize) and Shitsuke (Standardize) one of important tools in lean manufacturing, to reduce searching time, reworks and down time of machine. Besides 5s, the case study also identified 7 deadly wastes i.e. Overproduction, Waiting, Transportation, Unnecessary Inventory, Non Value Added Processing, Excessive Motion and Defects in Sewing Processes.

From the above study it has been found that Lean Manufacturing Practices are successful in developed countries. There is no dearth of study regarding the practice of Lean Manufacturing in promoting supply chain performances in RMG Sector of Bangladesh. With this backdrop, this study aimed to focus on the Practice of Lean Manufacturing with its Effects in Supply Chain Performances in Bangladesh Readymade Garments.

4 Research Methodology
This study was conducted in a selected garments manufacturing company, Adury Apparels Ltd., a sister concern of Thermax Group located at Narshingdi in Dhaka. Formal interviews with concerned managers have been conducted. This is followed by semi structured and informal interviews with managers; senior officers and in-charges to understand traditional practice and lean practice. Also, some data and information was collected through the observation of the production floor and maximum from past records. Besides the case study, an online survey was conducted to understand the awareness of lean practice in garments industry. Available literatures and subject matter experts have also been consulted for gathering required knowledge on lean manufacturing. Two hypotheses have been selected for this study and they are as follows:
H1: There is a significant difference in supply chain performance between traditional and lean manufacturing process

H2: There is a relationship amongst different supply chain performance measurement in lean manufacturing process.

5 Overview of Bangladesh Readymade Garments

The RMG industry plays a vital role in the Bangladesh economy. The economy of Bangladesh is largely dependent on agriculture. However, in recent years, the RMG sector has emerged as the biggest earner of foreign currency. It has experienced an exponential growth since the 1980s. The sector contributes significantly to the GDP. The industry plays a key role in employment generation and in the provision of income to the poor. Nearly four million workers are directly associated where one and half million are women workers. More than twelve million people are indirectly associated with this industry. The sector has also played a significant role in the socio-economic development of the country. An overwhelming number of workers in this sector are women. This has affected the social status of many women coming from low income families. The quota came to an end at 2004 but it continued to show robust performance, competitive strength and, most importantly social commitment. RMG’s contribution to Bangladesh economy is well-known, well-appreciated and well-respected. Garments industry is the largest export oriented industry for our country contributing 81% of total export (BGMEA, 2014).

Since the late 1970s, the RMG industry started developing in Bangladesh primarily as an export-oriented industry. Reaz Garments, the pioneer, was established in 1960 as a small tailoring outfit, named Reaz Store in DHAKA. It served only domestic markets for about 15 years. In 1973 it changed its name to M/s Reaz Garments Ltd. and expanded its operations into export market by selling 10,000 pieces of men's shirts worth French Franc 13 million to a Paris-based firm in 1978. It was the first direct exporter of garments from Bangladesh (Sarker, 2011). Till the end of 1982, there were only 47 garment manufacturing units. The breakthrough occurred in 1984-85, when the number of garment factories increased to 587. The number of RMG factories shot up to around 2,900 in 1999. Bangladesh is now one of the 12 largest apparel exporters of the world, the sixth largest supplier in the US market and the fifth largest supplier of T-shirts in the EU market. The industry has grown during the 1990s roughly at the rate of 22%. The growth of the industry in terms of number of units and employment generation is shown in following graph. In FY 2014, there are 4222 garments factories and about 4 million employees engaged in RMG sector, 85 percent of them are women. According to BGMEA, 30 percent capacity of RMG sector is unutilized due to lack of skilled labor force. Since 2005, employment in RMG sector increases from 2 million to 4 million in FY 2014. As well as number of active factories increased from 4107 to 5600 in 2012-13. However, in 2013-14 the numbers of factories were 4222 as shown in figure 1 (Hasin, 2015).
Bangladesh is the second largest exporter of RMG to European Union which gained 12 percent market share in FY 2012. The country also had a significant 4.6 percent market share of exports of US market (Asian Development Bank, 2013). The exports of Bangladesh RMG to other countries like Australia, Canada, China, India, Japan and Turkey have been expanding. If Bangladesh cannot protect and serve the workers’ rights in the garment factories, she might face rapid fall in RMG exports. The challenge on the reduction of export had been forced to the government after the collapse of the unauthorized building called ‘Rana Plaza’, at Savar which killed more than one thousand garment workers’. USA suspended Bangladesh from getting the benefits of Generalized System of Preferences (GSP). European Union warned that Bangladesh might get suspension from getting preferential trade access if the country delays to take immediate steps to improve labor standards (The Daily Star, May 06, 2013). The European Union demands for immediate improvement of labor standards and factory conditions. If Bangladesh fails to do so European Union might also consider suspending Bangladesh from getting duty free access to its market. Bangladesh has to act quickly to prevent suspension as European Union is the country’s top trading partner which accounts for about 60 percent of her total exports (The Daily Star, May 06, 2013).

6 Lean Manufacturing in general

In the late 1980s, the term Lean Production was introduced in the book titled “The machine that changed the world” written by Womack, Jones & Roos (1990). “The idea of lean thinking comprises complex cocktail of ideas including continuous improvements, flattened organizational structures, team work, elimination of waste, efficient use of resources and cooperative supply chain management” (Green, 2000, p.524). Lean Manufacturing can be defined as: “A systematic approach of identifying and eliminating waste (non-value-added activities) through continuous improvement through ensuring the product at the pull of the customer in pursuit of perfection (Nash et al.,2006).” According to the National Institute of Standards and Technology Manufacturing Extension Partnerships Lean Network, USA, lean refers to systematically identifying and eliminating waste through continuous improvement using the pull production with a view to get perfection (Kilpatrick, 2003). Lean thinking focuses on value-added flow and the efficiency of the overall system. A part sitting in a pile of inventory is waste and the goal is to keep product flowing and add value as much as possible. The focus is on the overall system and synchronizing operations so that they be aligned and produced products at a steady pace. Lean manufacturing is a manufacturing philosophy that shortens the time between the customer order and the product build/shipment by eliminating sources of waste (Shingo, 1996). The popular definition of Lean Manufacturing and the Toyota Production System, is a comprehensive set of techniques which, when combined, allows you to reduce and eliminate the wastes. This will make the company leaner, more flexible and more responsive by reducing waste (Wilson, 2009).
There are five core concept of lean manufacturing as identified by Womack & Jones (1994) as shown in table 1.

<table>
<thead>
<tr>
<th>Ser</th>
<th>Concepts</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Value specification in the eyes of the customer</td>
<td>Need to specify what creates value from customer's point of view.</td>
</tr>
<tr>
<td>2</td>
<td>Identifying the value stream and eliminating waste</td>
<td>Need to identify all the activities (value stream) necessary to produce a product and eliminate all non-value added waste.</td>
</tr>
<tr>
<td>3</td>
<td>Making the flow of the value at the pull of the customer</td>
<td>Make those actions that create value flow without interruptions at the pull of the customer.</td>
</tr>
<tr>
<td>4</td>
<td>Empowering and involving the employees</td>
<td>Need to empower and involve the employees at the decision making.</td>
</tr>
<tr>
<td>5</td>
<td>Continuously improving for getting perfection</td>
<td>Need to focus on continuous improvement for the perfection.</td>
</tr>
</tbody>
</table>

Table 1: Core Concepts of Lean [Sources: Womack et al. (1994)]

Waste is any aspect of task or activity that does not add value to product. Waste is cost that buyer (customer) is not willing to pay for; it is any activity which does not transform product as per customer requirement. According to Toyota Production System, there are eight categories of waste found in manufacturing. These wastes reduce production efficiency, quality of work as well as increase production lead time. The categories are Overproduction, Excess Inventory, Waiting, Excess motion, Excess transportation, Dis-connectivity, Rework and Over processing.

7 Findings and Analysis

Traditional Vs. Lean Manufacturing Process – Adury Apparels Ltd

In Adury Apparels Ltd., there are three manufacturing processes to convert raw material into final product. Two practices are found in Adury, traditional practice and lean practice. To be competitive in manufacturing, Adury Apparels Ltd. introduced lean manufacturing into their production system. In traditional method, cutting, sewing and finishing floors are separate. Material flows from one floor to another floor. So, in traditional method, material flow pattern follows vertical flow system. In Lean method, cutting, sewing and finishing process are on same floor. There is less transportation, good communication among processes, less WIP compared to the traditional method. Therefore, material flow follows a horizontal flow system in lean method. Comparative study between Lean and Traditional manufacturing system relating to each process are discussed below:

Traditional Vs. Lean - Cutting Process

Cutting is the first process of material transformation in Adury Garment Industry. Out of two cutting floor, one floor is totally converted to lean method and another floor is running in traditional method. One of the important operations of cutting is fabric laying. Laying method is totally manual in both traditional and lean method. So, utilization of labor is an important factor while laying. In traditional practice, there are 10 workers involved in laying operations. Thus, in most of the time workers are either idle or doing unnecessary activities. On the other hand, in lean method, laying is done by 2 workers where labor utilization is maximized. Besides, in traditional method, there is underutilization of table space. As the length of marker is
big, worker seat on the table for laying, some space is occupied by inventory of previous order. In lean method, two laying are performed at the same time from both side of table, thus space utilization is optimized. There is no excess inventory in lean method. Introduction of Kanban system reduces excess inventory between sewing and cutting. In traditional method space under the table is disorganized. In lean method, space under the table is used to keep kanban, thus space utilization increases.

**Traditional Vs. Lean - Sewing Process**

Sewing is the center of garments manufacturing process. Main transformation is accomplished at this stage. In traditional method, Operations layout pattern is straight line, which is long layout. According to operation management we could call this layout as Product layout. Input from cutting is delivered by big poly bag. Average bundle size is 25 to 30 pieces, which impacts on throughput time. As one operator has completed one full bundle then he/ she starts working on next bundle. Besides, there is bundle open and close time which also impact on throughput time and Standard Minute Value (SMV). In traditional practice, every worker is thinking about his own hourly output rather considering about line output. That is why at the end of the day there is huge Work in Progress inside line. As the line layout is long it is hard to balance between workers by team concept. Traditional practice worker do not concentrate on product quality they only focus on production rate per hour, that is why when order quantity is small there is high quality defect found by end line quality checker. But if the order quantity is big then defects rate is comparatively low. In traditional method, SMV is quite big compared to the lean method, as there is bundle handling time, matching time and marking time. Besides in traditional practice each operator is assigned with one operation there is combination of operation. If two similar machine operations are combined then one picks up and dispose time is reduced. Due to long layout, it is hard to balance among workers, thus there is waiting time among workers. Finally at the end of the day efficiency of the line goes down. In traditional line, it is regular practice to work excess overtime to meet daily production target. According to compliance rule, each worker could work each day 2 to 3 hours extra as overtime besides his/ her regular 8 hours working time, not more than that. In traditional practices for example in a Polo shirt line there are 37 operations, total SMV is 9.80 minutes. Total number of labor is 60 out of those machine workers 46, helpers 10 and 4 quality checkers.

In Lean Method, operations layout pattern is zigzag, which is in small layout. It is a flexible manufacturing system compare to traditional practice. According to operation management we could call this layout as group layout. Input from cutting is delivered by kanban box where inputs are well organized and visual. To control inventory between cutting and sewing, maximum 4 kanban are allowed in sewing. When it turns into 2 then a signal is sent to cutting for sending next input. Even accessories are sent with Kanban from cutting; so that supervisor has less effort to organize those and there is lesser chance to attach wrong level to body. Instead of small bundle full cake of cut fabric send to sewing, there is no bundle opening and closing time by machine operator. In lean manufacturing, workers are more focused on team output rather than individual work. As a result they work as a team and help each other thus balance themselves as per required takt time. For proper balancing a machine worker carries out two operations. Thus, workers’ waiting time is reduced and labor utilization is increased which impact on efficiency. Even they focus on quality, like in every 5 pieces, one piece is checked by worker to ensure quality from needle point rather than end line quality controller. Material flow is much faster in lean method as worker passes 10 pieces between operations. Due to integrating lean method, sewing lead time reduces and efficiency increases. As efficiency increases, it reduces extra overtime hours. To sustain efficiency level Adury management introduced production incentive based on efficiency level thus floor people find a new way to enhance their earning. In lean method for a
Polo shirt line, there are 28 operations. Total SMV is 6.65 minutes. Total number of labor is 18 out of them machine workers 16, helpers one and one quality checker. As in lean method, finishing is integrating with sewing team. It creates further benefit to them which will be discussed in finishing process.

**Traditional Vs. Lean - Finishing Process**

Finishing is the final stage of garments manufacturing process. Finishing operations are mainly manual jobs (hand work) which do not require machines. Only for iron and button attachment few machines are used. Traditional practice, sewing and finishing are in separate section. Adury have separate finishing section including packing section, where management and worker are separate than sewing. Instead of focusing on final objective, a batch of worker is doing same job, thus repetitive works take place which results longer lead time and less efficiency. Since similar skilled worker grouped together to perform a job, this layout is called Process layout. In packing area, final packing of two pieces of Polo shirt is done by 9 persons. After implementing lean, this task is done by one person. Thus all repetitive pick up and dispose are eliminated, and reduce cycle time as well throughput time is reduced. In Traditional practice, there are 12 steps or operations needed to complete Finishing and Packing operations. Total cycle time of all operations is 259 seconds or 4.32 minutes.

In Lean practice, Finishing is incorporated with sewing. Thus it reduced overhead cost, reduced lead time of manufacturing and increased efficiency. A small team of 4 to 5 workers work together and help each other thus they maintain balance among them and ensure maximum product flow. Size is segregated in finishing and put into trolley. So, there is no repetition of activity of size segregation in packing. Reliability among sewing and finishing team is established. If there is any sewing defect found, that is corrected immediately rather than waiting for long time in traditional system. Repetitive elemental activities are removed from new operation based on final objective, thus cycle time is reduced. In Lean practice, there are 5 steps or operations needed to complete Finishing and Packing operations. Total cycle time of all operations is 201 seconds or 3.35 minutes. The team completes up to poly bagging. After that it is passed through needle detector. Then based on size ratio final packing is completed.

**Test of Hypotheses and Analysis**

There is a significant difference in *supply chain performance* between traditional and lean manufacturing process

The stated hypothesis has been tested with the primary data collected through a questionnaire survey. The details of the test have been put in Table 2. The supply chain performance averages have been calculated for both lean and manufacturing process of Adury Apparel Ltd. The required test has been conducted to find out the significant differences amongst selected performance measurement between two manufacturing process.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Average</th>
<th>Variance Test (assumed equality of variance)</th>
<th>Mean Test (assumed equality of mean differences)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tradition</td>
<td>Lean</td>
<td>F-statistic</td>
</tr>
<tr>
<td>Efficiency</td>
<td>0.41</td>
<td>0.59</td>
<td>0.95</td>
</tr>
<tr>
<td>Produced Minute</td>
<td>6464.39</td>
<td>8849.66</td>
<td>3.50</td>
</tr>
<tr>
<td>Quality (RFT)</td>
<td>0.93</td>
<td>0.96</td>
<td>0.45</td>
</tr>
</tbody>
</table>
The test result suggests that seven performance measurements out of eight are significantly improved in Lean compared to traditional manufacturing process. One of the eight measurements i.e. Average Wage is increased in lean manufacturing from traditional manufacturing process but the improvement or increase in average wage is not significant. Average wage should also be significantly improved in lean manufacturing but result shows improvement is not satisfactory. One of the possible rationales for insignificant improvement of the average wage is that owners are reluctant to increase wage level for lean manufacturing process though company is experiencing significant improvement in all supply chain performance measurements.

The test (shown in Table 3) suggests that with the switching from traditional to lean manufacturing process all the performance measurements improved in the expected direction at 1% level of significance except for average wage.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Regression Coefficient (0=Traditional &amp; 1= Lean)</th>
<th>Intercept</th>
<th>R-square</th>
<th>Adjusted R-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>0.178***</td>
<td>0.41</td>
<td>0.76</td>
<td>0.75</td>
</tr>
<tr>
<td>Produced Minute</td>
<td>0.137***</td>
<td>3.80</td>
<td>0.35</td>
<td>0.34</td>
</tr>
<tr>
<td>Quality (RFT)</td>
<td>0.030***</td>
<td>0.93</td>
<td>0.89</td>
<td>0.89</td>
</tr>
<tr>
<td>Space Utilization</td>
<td>0.212***</td>
<td>1.81</td>
<td>0.33</td>
<td>0.32</td>
</tr>
<tr>
<td>Lead Time</td>
<td>-0.265***</td>
<td>1.71</td>
<td>0.91</td>
<td>0.91</td>
</tr>
<tr>
<td>Labour turnover</td>
<td>-0.36***</td>
<td>0.06</td>
<td>0.58</td>
<td>0.58</td>
</tr>
<tr>
<td>Absenteeism</td>
<td>-0.045***</td>
<td>0.08</td>
<td>0.65</td>
<td>0.64</td>
</tr>
<tr>
<td>Average wage</td>
<td>0.016</td>
<td>3.80</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Table 3: Regression Analysis [***significant at 1% level]

However, wage has also been increased for the employers but still requires associating wage level with level of output workers delivering following the lean manufacturing process.

In order to identify how the performance indicators in lean practice influence each other’s, the Pearson correlation coefficient has been calculated and tested (shown in Table 4). Result shows that among the eight indicators some are positively correlated, some are negatively, and some others indicators has no correlation between each other.
<table>
<thead>
<tr>
<th></th>
<th>Efficiency</th>
<th>Produced Minute</th>
<th>Quality</th>
<th>Space Utilization</th>
<th>Lead Time</th>
<th>Labour turnover</th>
<th>Absenteeism</th>
<th>Average wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Produced Minute</td>
<td>0.31*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td>0.12</td>
<td>0.23</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Utilization</td>
<td>0.39**</td>
<td>0.88***</td>
<td>0.29*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Time</td>
<td>0.19</td>
<td>-0.23</td>
<td>-0.08</td>
<td>-0.29</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour turnover</td>
<td>-0.52**</td>
<td>-0.29</td>
<td>0.35*</td>
<td>-0.24</td>
<td>0.04</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absenteeism</td>
<td>-0.64***</td>
<td>-0.16</td>
<td>-0.12</td>
<td>-0.37**</td>
<td>-0.39**</td>
<td>0.10</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Average wage</td>
<td>0.72***</td>
<td>0.58***</td>
<td>0.04</td>
<td>0.71***</td>
<td>0.03</td>
<td>-0.45**</td>
<td>-0.74***</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 4: Regression Analysis** [***significant at 1% level, ** significant at 5% and * significant at 10%]

The correlation between efficiency and produced minutes is found 0.31, indicates if efficiency increases then the produced minutes will also increase. In case of labor turnover and absenteeism, efficiency is found to play significant negative role that means if efficiency increases, then labor turnover and absenteeism decrease significantly. It is also found the increment in average wage resulted in less absenteeism in the organization. Correlation analysis also suggests that there are relationships with one performance measurement with the other at 10% level of significance. Efficiency has significant relationship with all other performance measurement except for quality and lead time. Though quality and lead time also have relationship with efficiency but not significant; implying that there are few other reasons accountable for improvement of these two performance measurements.

8 Conclusion

This study gives an overview of Bangladesh readymade garment industry, the employment opportunity created by this industry and the contribution of this sector to national economy. Besides, it gives a conceptual discussion on lean manufacturing, its principle, concept, wastes and different lean tools. Then it visualizes the changes in working method through lean practice in selected readymade garments, Adury Apparels Ltd. Finally it measures the performance of supply chain indicator between traditional and lean method in Adury Apparels Ltd. From data analysis, it has been found that, on an average, efficiency has been improved 44% following the lean method of production. Then lead time has been reduced up to 45%. Besides, there are improved results in quality performance (RFT). These three indicators represent how lean could help a RMG factory on their key challenging areas where they need improvement to survive on international competition. The study also observed a significant amount of reduction in absenteeism (57%) and labor turnover (50%) with the introduction of lean manufacturing practice in Adury Apparels Ltd.
References


