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ACHIEVING OPERATIONAL EXCELLENCE IN PRODUCTION PROCESS THROUGH LEAN MANUFACTURING: AN EMPIRICAL STUDY ON RMG INDUSTRY OF BANGLADESH

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Abstract: *Lean manufacturing has become a buzzword of new era. It is a whole-systems approach that creates a culture in which everyone in the organization continuously works to improve processes and production, to minimize delays, to reduce costs and improve quality, and to provide maximum value to customers. The benefits of lean manufacturing are evident in factories across the world. The purpose of the study is to achieve operational excellence in production process through lean manufacturing focused on Garments Industry of Bangladesh. This study is quantitative in nature. The study result shows that lean tools have significant influence in achieving operational excellence in manufacturing process. Total productive maintenance, just-in-time, set-in-order, standardization, sustainability, response time, product availability, and customer experience have been found highly significant at 5% level. Lean manufacturing is relatively new concept and is not properly implementing in Bangladesh. This concept is a vital tool for achieving overall operational excellence in Ready Made Garment (RMG) industry of Bangladesh if it is properly promoted, communicated, and implemented.*

Keywords: *Lean Manufacturing, Lean Tools, Operational Excellence, Ready Made Garments (RMG) Industry.*

INTRODUCTION

Every company's financial success depends on its ability to satisfy customers by creating sufficient demand for its products and services so the company can make sufficient revenues and profits. Customers demand quality products and on-time delivery. That is why companies concentrate on getting improved productivity, quality, lead-time, waste reduction as well as overall efficiency in manufacturing and business operation. For the past few years almost every manufacturing industry has been trying to get 'lean' to improve manufacturing performance. In today's competitive and changing business world, lean manufacturing (LM)

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philosophy has brought changes in management practices to improve customer satisfaction as well as organizational effectiveness and efficiency. It improves operating performance by focusing on the quick and uninterrupted flow of products and materials through the value stream. It is mentionable that value steam mapping are required to bring a product or a group of products that use the same resources through the main flows, from raw material to the arms of customers. These actions are those in the overall supply chain including both information and operation flow, which are the core of any successful lean operation. Value stream mapping is an enterprise improvement tool to assist in visualizing the entire production process, representing both material and information flow (Peash, 2012). To achieve this, various forms of manufacturing waste must be identified and eliminated. Now, many countries have started to practice lean tools in hotel, pharmaceuticals, automobiles, garment, and other industries. They observed tremendous improvement in their operation. Supply chain management considers both inbound (upstream) and outbound (downstream) flow of materials, services and goods to the firm. Lean production can maintain balance in both aspects of supply chain (Lambert et al., 1998). The implementation of a lean manufacturing strategy represents a robust contribution to the phase sequence that leads to operational excellence and the continuous improvement through the elimination of non-value added activities. The major purposes of the use of lean technique are to increase productivity, improve product quality and manufacturing cycle time, reduce inventory, reduce lead-time and eliminate manufacturing waste. In brief, lean production focus on more value with less work. Lean tools and techniques are frequently using in garments industry in order to improve their overall manufacturing performance, which is making them more competitive and successful in their area. This study is hoped to provide useful knowledge and guidelines of Lean manufacturing to RMG sector of Bangladesh.

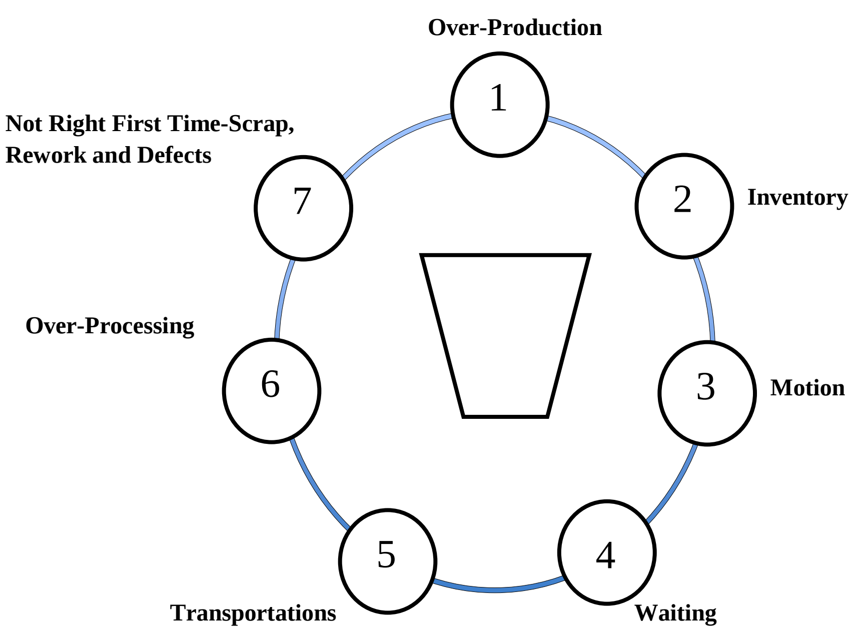
LITERATURE REVIEW

Lean can be defined as “A systematic approach to identify & eliminate waste (Non Value added Activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection.” Lean Production concept was introduced by a book titled *The Machine that Changed the World* written by Womack et al. (Piciacchia, 2003). The tools and techniques of lean manufacturing (LM) have been widely used in the discrete industry starting with the introduction of the original Toyota Production System. Tools including just-in-time, cellular manufacturing, total productive maintenance, single-minute exchange of dies, and production smoothing have been widely used in discrete parts manufacturing sectors such as automotive, electronics and appliance manufacturing (Peash, 2012). The lean concept spread to Japanese factories after it was first implemented in the Toyota Motor Company (Papadopoulou and

Ozbayrak, 2005). This is a Japanese concept applied in manufacturing firms. The Japanese firms (firms in other countries as well) have been using this concept to reduce the cost of any process (be it service or manufacturing) by removing waste (Ferdousi and Ahmed, 2009). The idea of lean thinking comprises complex cocktail of ideas including continuous improvements, flattened organization structures, team work, elimination of waste, efficient use of resources and cooperative supply chain management" (Green, 2000). Haque (2008) stated that LM shortens the time between the customer order and the product build or shipment by eliminating sources of waste. Another way of looking at lean is that it aims to achieve the same output with less input- less time, less space, less human effort, less machinery, less material, and less costs. On the other hand, Total Productive maintenance (TPM) is more effective in Lean driven enterprises. Main focus on the relationship between Lean and TPM, by comparing their goals and principles as well as how Lean and TPM can strengthen each other's results in order to reach sustainable growth of the organization. Merging the benefits of two well-known methodologies, Lean Thinking and Total Productive Maintenance, "Lean TPM" shows how to secure increased manufacturing efficiency. Lean goals are not achievable without reliable machinery and processes (Haque et al., 2008). Like Lean, TPM requires employees' involvement in all levels throughout the organization (Houshmand and Jamshidnezhad, 2006). An important tool that is necessary to account for sudden machine breakdowns is total productive maintenance. In almost any lean environment setting a total productive maintenance program is very important. Lean manufacturing, often called (JIT) or Agile Manufacturing, is an operating strategy that seeks to maximize operational effectiveness by creating value in the eyes of the end customer. The focus is not on a department, area or process, but on the optimization of the entire value stream --the series of processes between receipt of customer order and delivery of finished product (lean.org). LM is based on "Just-in-Time" production achieved by following three stages: Customer demand (When it is required, in the quantity required), continuous flow (flowing work to ensure that the right work unit arrives at the right time), and leveling work (flexibility to distribute work evenly and effectively) (psesbd.org). Lean production philosophy uses several concepts such as one-piece flow, kaizen, cellular manufacturing, synchronous manufacturing, inventory management, standardized work, work place organization, and scrap reduction to reduce manufacturing waste (Russell and Taylor, 1999). The main reasons for adopting a lean system under three broad categories: reducing production resource requirements and costs, increasing customer responsiveness, and improving product quality. It concluded that all of these combine to boost company profits and competitiveness (EPA, 2003). Now, many countries have started to practice lean tools in the garment industry. This practice has improved their productivity, quality and lead-time and also made their customer more responsive. In addition to this lean production involves, motivates and develop employee skills and knowledge through education and multi-skilling program (Mazany, 1995). Knowledge is a necessary and sustainable source of competitive advantage. Knowledge capital is important to business quality and capacity (Spagat, 2005). Knowledge allows the organization to solve problems and seize opportunities. So, knowledge regarding lean production can create efficiency in the operations of the businesses, which are involved in manufacturing and production process (Earl and Scott, 1999). Technology acquisition improves a firm's performance. Firms with acquired technologies accumulate capital much more quickly than firms without such technologies during regulated periods. These results imply that in technology acquisition licensing, the government screens a firm's application based on: **(a)** the industry to which the firm belongs, and **(b)** its experience with technology acquisition. Furthermore, part of rent based on restricted access to foreign technologies. Lean is a concept, which really has strong correlation with effective use of technology (Kiyota and Okazaki, 2005).

Shigeo Shingo identified "Seven" forms of waste (Figure 01).

Figure 01: The 7 Wastes



Source: (lean.org)

Overproduction is highly costly to a manufacturing plant because it prohibits the smooth flow of materials and actually degrades quality and productivity. Excess inventory increases lead time, consumes productive floor space, delays the identification of problems, and inhibit communication. Motion waste is related to ergonomics and is seen in all instances of bending, stretching, walking, lifting, and reaching. Whenever goods are not moving or being processed, the waste of waiting occurs. Much of a product's lead-time is tied up in waiting for the next operation. Transporting product between processes is a cost incursion, which adds no value to the product. Excessive movement and handling cause damage and are an opportunity for quality to deteriorate. Processing beyond the standard required by the customer by improving processing efficiency we ultimately use less resource to achieve the same customer satisfaction. Non-Right First Time (Scrap, Rework and Defects) means having a direct impact to the bottom line, quality defects resulting in rework or scrap are a tremendous cost to organizations. Associated costs include quarantining inventory, re-inspecting, rescheduling, and capacity loss. (lean.org). Closely associated with lean production is the principle of just-in-time (JIT), since it is a management idea that attempts to eliminate sources of manufacturing waste by producing the right part in the right place at the right time. This addresses waste such as work-in-process material, defects, and poor scheduling of parts delivered. (ifm.eng.cam.ac.uk).

The five-step thought process for guiding the implementation of lean techniques is easy to remember, but not always easy to achieve: **(a)** Specify value from the standpoint of the end customer by product family **(b)** Identify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value **(c)** Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer. As flow is introduced, let customers pull value from the next upstream activity, **(d)** As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, and **(e)** Begin the process again and continue it until a state of perfection is reached in which perfect value is created with no waste (lean.org).

Continuous improvement is another fundamental principle of lean manufacturing. Kaizen, which is the Japanese word for a continuous endeavor for perfection, has become popular in the west as a paramount concept behind good management. One of the most effective tools of continuous improvement is 5S, which is the basis for an effective lean company. 5S is a first, modular step toward serious waste reduction. 5S consists of the Japanese words Seiri (Sort), Seiton (Straighten), Seiso (Sweep and Clean), Seiketsu (Systemize), and Shitsuke (Standardize) (lmsi.ca). Another research Hhaled in 2011 explained the 5S in the following ways: **(a)** Seiri-**Sort**: The first step in making things cleaned up and organized, **(b)** Seiton-**Set In Order**: Organize, identify and arrange everything in a work area, **(c)** Seiso-**Shine**: Regular cleaning and maintenance, **(d)** Seiketsu-**Standardize**: Make it easy to maintain -simplify and standardized, and **(e)** Shitsuke-**Sustain**: Maintaining what has been accomplished.

Lean manufacturing can also contribute to other components in business to provide the customer better service which consists of many components. This concept can focus on those measures that are influenced by the structure of the distribution network. These include: response time, product variety, product availability, customer experience, order visibility and returnability.

Companies such as Toyota, Pratt and Whitney, Sikorsky, Delphi, Ford and many other companies have achieved large savings by implementation of lean principles in their manufacturing activities (Schmidt, 2000). The garment industry has opportunities to improve, but requires some changes. Under the highly competitive environment, the garment industry has numerous opportunities for improvement using lean principles (Mercado, 2007). The companies that adopt lean production as a working philosophy within their organizations can make significant improvement in terms of their operational performance even if it is in a modified format that best suits their particular business culture (Ferdousi and Ahmed, 2009).

The readymade garment sector (RMG) is the hub of the economy of Bangladesh, accounting for more than 78% of the country's total export earnings. It is likely that the future economic development of Bangladesh will be highly correlated with this sector performance (Shahidullah, 2012).

In the face of fierce competition resulting from the rapid globalization of businesses in Bangladesh, some companies across the garment industry sector have been practicing lean manufacturing to remain globally competitive and create a strong market position. But very few companies are practicing Lean approach. Moreover there is a lack of research evidence regarding the impact of lean practices on manufacturing performance improvement in Bangladeshi garment firms Through the implementation of lean, the garment sector can reduce costs, lead time, increase customer responsiveness, ensure order visibility, and reduce the rate of return after purchasing products through reducing several types of waste from the production process (Ferdousi and Ahmed, 2009).

All companies want to improve their productivity, which is measured by the ratio of inputs (labor, capital, etc.) used to outputs produced. Major improvements can be realized from the elimination of waste (i.e., all non-value-added activities) through standardization of work practices and efficient use of the work force, space and machinery. Other substantial improvements (innovations) may emerge from machinery upgrading, quality system enhancement, and adopting more economical production methods. Overall productivity levels of the Bangladesh RMG sector are low compared to regional competitors. Hence, there is a significant potential to increase the competitiveness of the industry (www.lean.org). In spite of having great importance of lean approach in the manufacturing sectors, sufficient study regarding lean manufacturing has not been found in Bangladesh. That is why, this study has been conducted to better understand the lean manufacturing as well as identify the tools and techniques related to this concept and measure the impact of those tools on achieving operational excellence in production process of a Ready Made Garment of Bangladesh in a quantitative manner.

OBJECTIVES

The broad objective of this study is to achieve operational excellence in production process through lean manufacturing focused on RMG Industry of Bangladesh. There are some other specific objectives of this study. These are given below:

1. To identify various lean manufacturing tools.
2. To explore how the identified lean tools lead to obtain operational excellence in the production process of a garment company.
3. To identify the business challenges faced by garment industry of Bangladesh to practice lean.
4. To identify the areas where changes need to be made to implement lean in garment industry of Bangladesh.

RESEARCH QUESTIONS AND HYPOTHESIS DEVELOPMENT

The research questions and proposed hypotheses of this study are summarized below:

RQ_1 : Is total productive maintenance (TPM) effective in lean driven enterprises?

$H_0 1$: Total productive maintenance (TPM) is not effective in Lean driven enterprises.

RQ_2 : Can just-in-time concept be easily maintained through lean manufacturing?

$H_0 2$: Just-in-Time concept cannot be easily maintained through lean manufacturing.

RQ_3 : Can sorting be performed effectively to implement the lean manufacturing?

H_0 3 : Sorting cannot be performed effectively to implement the lean manufacturing.

RQ_4 : Can set-in-order be a major concern while implementing the lean manufacturing?

H_0 4 : Set-in-order cannot be a major concern while implementing the lean manufacturing.

RQ_5 : Can shining environment be maintained to execute the lean manufacturing?

H_0 5 : Shining environment cannot be maintained to execute the lean manufacturing.

RQ_6 : Is standardization the major tool to implement lean manufacturing?

H_0 6 : Standardization is not the major tool to implement lean manufacturing.

RQ_7 : Can sustainability in the market be possible through the use of lean manufacturing?

H_0 7 : Sustainability in the market cannot be possible through the use of lean manufacturing.

RQ_8 : Will Response time be faster while implementing the lean manufacturing?

H_0 8 : Response time will not be faster while implementing the lean manufacturing.

RQ_9 : Can the product be made available effectively by following the techniques of lean manufacturing?

H_0 9 : The product cannot be made available effectively by following the techniques of lean manufacturing.

RQ_{10} : Will customer experience be better when a firm uses lean manufacturing approach?

H_0 10 : Customer experience will not be better when a firm uses lean manufacturing approach.

RQ_{11} : Will rate of return be decreased through the use of lean manufacturing technique?

H_0 11 : The rate of return will not be decreased through lean manufacturing technique.

METHODOLOGY

A research design is a framework or blueprint for conducting marketing research project (Malhotra and Satyabhushan, 2011). There are two helpful research methodologies: quantitative and qualitative. As the purpose of this research is to test the proposed hypothesises, so a descriptive research (quantitative method) was chosen in this research to understand the relationship between dependent and independents variables. Primary data was collected by applying survey method. Secondary was collected from various articles, books, journals and web based publications.

The target population of this study is the listed Garments companies of Bangladesh. The sampling frame for this research is the list of registered garments companies in BGMEA (Bangladesh Garments Manufacturers and Exporters Association) and BKMEA (Bangladesh Knit Manufacturers and Exporters Association). A simple random sampling technique (lottery method) was followed to select five Garments. Data was collected from thirty respondents from the selected garments' employees of various departments- procurement and purchasing, inventory management, production, technical, logistics, and marketing. The respondents have sufficient knowledge regarding lean manufacturing concept so that they understand each and every word regarding lean used in the primary data collection instrument. A semi-structured questionnaire with both open-ended and close-ended questions was developed to collect data. The researchers themselves collected data. Multiple regression was been carried out to know the impact of independent variables on dependent variable. Eleven independent variables have been identified. All of the items were measured by using the 9 point Likert Scales anchored by 1=Extremely Disagree, 2=Strongly Agree, 3=Somewhat Disagree, 4=Disagree, 5=Neutral, 6=Somewhat Agree, 7=Agree, 8=Strongly Agree, and 9=Extremely Agree. Likert scale method was used because it produces a good reliability and validity outcome.

Here Dependent Variable is- Operational excellence in production process through lean manufacturing (LM). Independent variables: **(a)** Total productive maintenance, **(b)** Just-in-time, **(c)** Sorting, **(d)** Set-in-order, **(e)** Shining environment, **(f)** Standardization, **(g)** Sustainability, **(h)** Response time, **(i)** Product availability, **(j)** Customer experience, and **(k)** Rate of return. Collected data was processed through quantitative method using the Statistical Package for the Social Sciences (SPSS 16.0).

Population regression equation:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + e$$

Where, Y=Operational excellence in production process through lean manufacturing.

β_0 = Constant, X_1 = Total productive maintenance, X_2 = Just-in-Time, X_3 = Sorting, X_4 = Set-in-order, X_5 = Shining environment, X_6 = Standardization,

X_7 = Sustainability, X_8 = Response time, X_9 = Product availability, X_{10} = Customer experience, X_{11} = Rate of return, and e = Error

Hypothesis and coefficient of multiple determination testing (R^2 testing): From the hypothesis and regression model, it can be specified that,

H_0: $R^2 = 0$ (exist no relationship between dependent variable and independent variables= Accept null hypothesis).

H_1: $R^2 \neq 0$ (exist relationship between dependent variable and independent variables= Accept alternative hypothesis).

Researchers have taken eleven variables to examine their effect on achieving operational excellence in production process of RMG of Bangladesh. There may be many other lean tools, which may affect continuous improvement in production process. Therefore addition of more variables (lean tools) and samples would have been produced better result.

FINDINGS AND ANALYSIS

Respondents are asked to cite what they think about the impact of lean manufacturing techniques on achieving operational excellence in production process. They responded in a positive way. Of the total thirty respondents 10 percent extremely agree, 43.3 percent respondents strongly agree, 30 percent agree, 10 percent somewhat agree and 6.7 percent has given neutral opinion respectively. Every respondent think that lean manufacturing technique contributes in achieving operational superiority as well as makes the garments production more efficient (Table: 04).

Respondents' responses regarding each independent variable are given in the appendix section with the use of frequency distribution.

The model summary is given below:

Table 01: Results of Regression Analysis

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.814	.767	.635	.83142
Predictors: (Constant), Rate_of_Return, Sustainability, Response_Time, Shining_Environment, Standardization, Total_Productive_Maintainance, Sorting, Customer_Experience, Set_In_Order, Product_Availability, Just_In_Time				

It is known that R^2 indicates the strengths of association between the independent variables and dependent variable. The higher the value of R^2, the higher the strengths of association between the dependent and independent variables as well as the consideration of how much the variation in the dependent variables can be explained by the variation in the independent variables. The value of R^2 in this case is 0.767, which implies that 77 percent variation in dependent variable is due to the variation in the independent variables. Here Adjusted R^2 is .635. The difference between R^2 and Adjusted R^2 is around 13 percent, which s large. It indicates that the addition of new independent variables may affect the regression result.

Table 02: ANOVA

ANOVA[b]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	73.273	11	6.661	8.244	.002[a]
	Residual	14.539	18	.808		
	Total	87.812	29			
a. Predictors: (Constant), Rate_of_Return, Sustainability, Response_Time, Shining_Environment, Standardization, Total_Productive_Maintainance, Sorting, Customer_Experience, Set_In_Order, Product_Availability, Just_In_Time						
b. Dependent Variable: Operational_Excellence_Production_Process_Lean Manufacturing						

From ANOVA table, it can be seen that the significance value is .002, which is less than at .05 (significance level). The critical value of F for 11 and 18 degrees of freedom is about 2.34. Because the calculated value of F is 8.244, which is larger than the critical value, therefore the null hypothesis is rejected. It means the independent variables affect on dependent variable.

Table 03: Regression Coefficients

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.566	2.671		.931	.368
	Total_Productive_Maintenance	.165	.112	.417	4.012	.002
	Just_In_Time	.561	.125	.557	3.143	.006
	Sorting	-.051	.135	-.059	.381	.634
	Set_In_Order	.114	.120	.384	3.881	.003
	Shining_Environment	.143	.108	.049	.323	.347
	Standardization	.103	.117	.284	2.811	.006
	Sustainability	.175	.100	.294	3.746	.000
	Response_Time	.164	.109	.372	3.605	.013
	Product_Availability	.218	.113	.279	2.343	.042
	Customer_Experience	.221	.110	.338	2.012	.004
	Rate_of_Return	-.184	.140	-.367	.247	.714

a. Dependent Variable: Operational_Excellence_Production_Process_Lean Manufacturing

Therefore the sample regression equation is:

$$\hat{Y} = \alpha + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11}$$

$$\hat{Y} = 2.566 + 0.417x_1 + 0.557x_2 - 0.059x_3 + 0.384x_4 + 0.049x_5 + 0.284x_6 + 0.294x_7 + 0.372x_8 + 0.279x_9 + 0.338x_{10} - 0.367x_{11}$$

Table-3 shows that majority of the variables are really significant to contribute in lean manufacturing. These factors are- Total Productive Maintenance, Just-In-Time, Set-In-Order, Standardization, Sustainability, Response Time, Product Availability, and Customer Experience. Other three variables-sorting, Shining-Environment, and rate of return have not been found significant with the value of

0.634, 0.347 and 0.714 respectively, which are greater than at .05 (significance level). The standardized beta coefficients of Total Productive Maintenance is 0.417, Just-In-Time is 0.557, Set In Order is 0.384, Standardization is 0.284, Sustainability is 0.294, Response Time is 0.372, Product Availability is 0.279, and Customer Experience is 0.338 (Table: 03). So, it can be said that these eight independent variables influence in achieving operational excellence in production process. Among these variables TPM (total productive maintenance) and just in time have been found as more significant dimensions because the beta coefficient for these dimensions are .417 and .557 respectively, which are greater than other dimensions.

So, the result of hypothesis testing:

Hypotheses	Description	Decision
H_o 1	TPM is not effective in Lean driven enterprises	Null hypothesis rejected
H_o 2	Just-in-Time concept cannot be easily maintained through lean manufacturing.	Null hypothesis rejected
H_o 3	Sorting cannot be performed effectively to implement the lean manufacturing.	Null hypothesis accepted
H_o 4	Set-in-order cannot be a major concern while implementing the lean manufacturing.	Null hypothesis rejected
H_o 5	Shining environment should not be maintained to execute the lean manufacturing.	Null hypothesis accepted
H_o 6	Standardization is not major tool to implement lean manufacturing.	Null hypothesis rejected
H_o 7	Sustainability in the market cannot be possible through the use of lean manufacturing.	Null hypothesis rejected
H_o 8	Response time will not be faster while implementing lean manufacturing.	Null hypothesis rejected
H_o 9	The product cannot be made available effectively by following the techniques of lean manufacturing.	Null hypothesis rejected
H_o 10	Customer experience will not be better when a firm uses lean manufacturing approach.	Null hypothesis rejected
H_o 11	The rate of return will not be decreased through lean manufacturing.	Null hypothesis accepted

CONCLUSION AND RECOMMENDATIONS

Lean manufacturing reduces all forms of non-value added activities in organizations and improves its performance. The garments companies, which want to implement Lean manufacturing approach in their organizations can surely work with the variables appropriately for implementing the lean concept effectively and get better result in manufacturing performance. This study has attempted to know how lean manufacturing approach contributes in achieving operational excellence in production process focused on Garments industry of Bangladesh. Eleven variables (lean tools) have been identified through literature review, which are related to LM approach. It is found that 10 percent respondents extremely agree, 43.3 percent strongly agree, and 30 percent agree that companies that adopt lean manufacturing as a working philosophy within their organizations can make significant improvement in terms of their operational performance. They pointed out that though it is comparatively expensive to set the lean concept within organization, still this concept will pay long-term return to their company. Multiple regression analysis has been carried out to evaluate the contribution of each independent variable on dependent variable. The value of R^2 in is 0.767, which implies that 77 percent variation in dependent variables is due to the variation in the independent variables. Eight variables have been found significant- Total Productive Maintenance, Just-In-Time, Set-In-Order, Standardization, Sustainability, Response Time, Product Availability, and Customer Experience and other three variables have no influence in achieving operational excellence in the production process of a garment company.

Lean manufacturing is comparatively new concept in the context of Bangladesh. Therefore, many of the garments companies still do not have appropriate knowledge to implement the lean manufacturing concept effectively. It is also found that respondents believe implementation of lean strategy definitely make easier to achieve manufacturing superiority but its execution may be difficult because of lack of knowledge in this approach. They also cited that it requires large initial investment, which can demotivate the manufacturer to execute the lean concept. Still, if lean production concept is properly promoted and communicated to the manufacturer of the country, definitely this concept can be learned and adopted by the manufacturer successfully, which will make our manufacturing sectors specially garments sectors more efficient as well as competitive in the world market by eliminating manufacturing waste and non value added activities.

This study offers contribution on both theoretical and practical fields. This adds theoretical body of knowledge through a comprehensive review of the factors or tools of lean manufacturing to the supply chain and logistics management in the area of Garment industry of Bangladesh. It provides obvious knowledge about lean production tools, techniques, and strategies to manufacturers. Moreover, the findings suggest manufacturers about the advantages of the adoption of lean tools in the manufacturing process of a product or service. This study gives information to develop a "operational excellence model" as well as "manufacturing performance measurement model" through the adoption lean tools by providing an in-depth analysis of the variables-Total productive maintenance, Just-in-Time, Sorting, Set-in-order, Shining environment, Standardization, Sustainability, Response time, Product availability, Customer experience, Rate of return, and some other tools analyzed in this study. The findings pose an interesting area to pursue further research in other industries such as automobile, pharmaceuticals, hotels, electronics, consumer goods, and other discrete industries. It would be more illuminating to conduct a longitudinal study to understand the long-term effects and benefits of lean in Bangladeshi garment industry. Some meaningful recommendations that can be put forward for achieving operational excellence in production and business operation are commit to lean, learn about lean, develop the basic knowledge and skill for industrial engineering and quality control, implement trial concept, monitor and evaluate trial concept, integrate them into the new production process, and most importantly development of necessary physical infrastructure.

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Appendix

Table 04: Performance Improvement

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	2	6.7	6.7	6.7
	Somewhat Agree	3	10.0	10.0	16.7
	Agree	9	30.0	30.0	46.7
	Strongly Agree	13	43.3	43.3	90.0
	Extremely Agree	3	10.0	10.0	100.0
	Total	30	100.0	100.0	

Table 05: Total Productive Maintenance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	1	3.3	3.3	3.3
	Somewhat Agree	7	23.3	23.3	26.7
	Agree	9	30.0	30.0	56.7
	Strongly Agree	11	36.7	36.7	93.3
	Extremely Agree	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Table 06: Just-In-Time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely Disagree	2	6.7	6.7	6.7
	Strongly Disagree	5	16.7	16.7	23.3
	Disagree	5	16.7	16.7	40.0
	Somewhat Disagree	9	30.0	30.0	70.0
	Neutral	7	23.3	23.3	93.3
	Somewhat Agree	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Table 07: Sorting

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely Disagree	1	3.3	3.3	3.3
	Strongly Disagree	9	30.0	30.0	33.3
	Disagree	7	23.3	23.3	56.7
	Somewhat Disagree	7	23.3	23.3	80.0
	Neutral	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

Table 08: Set-In-Order

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely Disagree	4	13.3	13.3	13.3
	Strongly Disagree	8	26.7	26.7	40.0
	Disagree	11	36.7	36.7	76.7
	Somewhat Disagree	5	16.7	16.7	93.3
	Neutral	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Table 09: Shining Environment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely Disagree	1	3.3	3.3	3.3
	Strongly Disagree	10	33.3	33.3	36.7
	Disagree	11	36.7	36.7	73.3
	Somewhat Disagree	5	16.7	16.7	90.0
	Neutral	2	6.7	6.7	96.7
	Somewhat Agree	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Table 10: Sustainability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	1	3.3	3.3	3.3
	Somewhat Agree	5	16.7	16.7	20.0
	Agree	10	33.3	33.3	53.3
	Strongly Agree	12	40.0	40.0	93.3
	Extremely Agree	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Table 11: Response Time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	1	3.3	3.3	3.3
	Somewhat Agree	3	10.0	10.0	13.3
	Agree	5	16.7	16.7	30.0
	Strongly Agree	15	50.0	50.0	80.0
	Extremely Agree	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

Table 12: Product Availability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	2	6.7	6.7	6.7
	Somewhat Agree	1	3.3	3.3	10.0
	Agree	10	33.3	33.3	43.3
	Strongly Agree	11	36.7	36.7	80.0
	Extremely Agree	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

Table 13: Customer Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	3	10.0	10.0	10.0
	Somewhat Agree	6	20.0	20.0	30.0
	Agree	10	33.3	33.3	63.3
	Strongly Agree	8	26.7	26.7	90.0
	Extremely Agree	3	10.0	10.0	100.0
	Total	30	100.0	100.0	

Table 14: Rate of Return

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extreme Disagree	4	13.3	13.3	13.3
	Strongly Disagree	7	23.3	23.3	36.7
	Disagree	3	10.0	10.0	46.7
	Somewhat Disagree	8	26.7	26.7	73.3
	Neutral	4	13.3	13.3	86.7
	Agree	2	6.7	6.7	93.3
	Strongly Agree	2	6.7	6.7	100.0
	Total	30	100.0	100.0	