An Investigation of Lean Manufacturing Implementation in Textile Sector of Pakistan

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Abstract – This research explored the implementation of lean manufacturing practices in textile sector of Pakistan. Survey method was used to collect data from a sample of textile companies. The respondents comprised the managers of quality, production, and lean departments. The results of the study show that the textile sector is at the beginning stage of lean implementation. It lacks understanding of lean philosophy and concepts. More than half of the surveyed companies are in-transition to implement lean. The most important driver to implement lean practices was found to be organization's continuous improvement program followed by the drive to focus on customers, and desire to use best practices. The respondents perceived the cost reduction to be the biggest benefit that can be achieved by implementing lean, followed by customer satisfaction, and improved delivery time. Among process and equipment tools and techniques 5S, quality control circles, kaizen and SMED are used extensively. Manufacturing planning and control and related tools are still strangers. Human resource related factors like team effort and specialized and cross-functional training were perceived to be crucial to effectively implement lean. Lean production practices have a significant relationship with the size and the type of textile company and no relationship with the age of the company. Lack of awareness to implement lean, company culture, lack of communication, and employee resistance are the main barriers faced by the sample companies during the implementation of lean manufacturing.

Keywords: Lean manufacturing; textile and garments industry; barriers to lean

I. INTRODUCTION

Customer satisfaction is the main focus of all organizations [1]. With increased awareness customers are demanding more variety at less cost but with high quality and at fast delivery [2]. On the other hand the cost of manufacturing is increasing. Added to this challenge is the ever increasing competition due to globalization. As a result organizations are looking for ways of spending less and producing more. Lean production is the answer to this challenge, having proved during the last four decades.

Textile industry sector of Pakistan is considered as backbone of economy and is a major contributor both in terms of exports and employment. It contributes 8.5 percent to the GDP and employs over 40% of the manufacturing sector workforce [3]. Pakistan produces a variety of textile products, and is among top five producers and consumers of cotton [4]. However, it is the 8th largest exporter of textile products [5].

USA and EU are the demand drivers whereas the major competition in international market remains severe between Pakistan, Bangladesh, China, and India. In past few years, however, Bangladesh, China, and India have become more competitive in both quality and price than Pakistan. From the total volume (US$18 trillion per annum) of world textile trade, Pakistan's share is less than one percent. Implementation of lean production principles can help this sector emerge among this competition and regain its position in international market. Implementing lean not only improves customer satisfaction but also overall organizational efficiency and effectiveness [1]. However, only little work has been done to implement lean in Pakistan's textile sector. Most work has focused on just a set of tools of lean, and a holistic approach has been lacking. National Productivity Organization (NPO) with the cooperation of Asian Productivity Organization (APO) Japan and in collaboration with Small and Medium Enterprises Development Authority (SMEDA) organized many training programs in order to introduce the lean manufacturing concepts. The ultimate challenge has been to change the mindset of top management and increase awareness about lean practices [6]. However, a comprehensive study analyzing the extent of implementation of lean principles, their impact on organizational performance, and barriers to implementation is lacking. The purpose of this study is to fill this gap and to present a clear evidence on current status of lean implementation, its benefits, and challenges to implementation.

II. LITERATURE REVIEW

James Womack and his colleagues [7] used the term "lean production" in their book *The Machine that Changed the World*, that depicts the manufacturing concept set up by the Toyota Production System. Toyota Production System identified seven type of waste and proposed a number of highly developed manufacturing methods to minimize these wastes [8, 9].

Recently a lot of research has been conducted on process and system improvement with a focus on topics like lean production, total quality management, total productive maintenance, and their applications. Lean manufacturing is considered as the best production system of 21st century [10]. It requires least investment as compared to other manufacturing systems [11]; one of the most important reasons that makes it an ideal candidate for almost all types of organizations irrespective of their type and size.

Lean is a systematic approach that focuses on continuously improving quality, cost, delivery, and safety by eliminating waste, creating flow, and increasing the efficiency [12]. Lean production consists of the best features of both mass production and craft production [7]. It focuses on 'doing more with less' [13]. It is multi-dimensional approach comprising a number of best practices like kaizen [14], 5S [9], visual controls [15], just-in-time [16], total productive maintenance (TPM) [16, 17], single minute exchange of die (SMED) [17, 18], Poka-yoke [21], kanban and pull production [16, 17], quality systems, value stream mapping [16, 20, 21], human resource and supplier management [16] etc., along with a committed role by the leadership[12, 22] and motivated and empowered employees [23]. However, transforming an enterprise from traditional style of working to lean is not an overnight process. It involves a number of challenges [24] including a change in culture of the organization [17], strong relationships with the suppliers based on trust and long term commitment and equally strong relations with the customers. In general, the existence of innovative industrial business relations, the establishment or development of logistic and communication networks, the development of appropriate professional training and educational programs are all fundamentals for the development of the new "lean" manufacturing system [25]. According to Feld [22] the five primary elements for lean manufacturing system are: manufacturing flow, organization, process control, metrics, and logistics. Some organizations fail to appropriately implement the lean practices resulting in waste of time and resources. The major difficulties companies face in implementing lean are a lack of direction and planning and a lack of knowledge of adequate project sequencing [18]. Achanga [26] discovered four critical success factors for the successful implementation of lean - the most critical is leadership and management, followed by the financial capability, skill and expertise and organizational structure and culture.

The barriers in implementing of lean include [12, 19, 26, 27]:

- Company culture,
- Lack of top management commitment,
- Attitude of middle management,
- Lack of communication,
- Employee resistance,
- Back sliding to the old ways of working
- Lack of time to implement
- Lack of understanding to implement lean manufacturing concepts
- Budget constraints
- Failure of past lean projects

The cultural, social and economic conditions of Pakistan are quite different than western countries. Therefore, the implementation of lean in developing country like Pakistan might be different from that of developed nations. In Pakistan very little research has been made on lean production. Therefore, the existing literature does not give sufficient information about the nature and adoption level of lean practices in its textile sector. However, some work has been done in some neighboring developing countries. The results of a study in Bangladesh investigated the impact of nine lean production practices on organizational performance. The results showed that lean practices had a significant relationship with positive outcomes like decrease in unit production cost, up-scaling quality of products, the reduction of lead time in production process, reduction of manufacturing wastes and inventory [2]. The findings also showed that the Bangladesh's garment companies have adopted a wide variety of lean tools and techniques and achieved many performance improvements.

III. METHODOLOGY

A questionnaire was developed based on extensive literature review. It was sent to the respondent companies by email and, where possible, by personal visits. The follow up process was continued for 7 to 8 weeks. In order to check the internal reliability, Cronbach's alpha was used [28]. Overall reliability of the questionnaire used in this study was 0.82. A group of experts (lean experts, practitioners, textile managers, and academicians) confirmed the face validity of the questionnaire. Along with other features, the group also reviewed whether all the items or

indicators in the questionnaire were relevant to measure respective constructs or not and showed satisfaction with the construct validity.

A total of 250 questionnaires were sent to different textile companies. Five questionnaires were sent to individual company. Respondents included the executives and the senior managers from quality, lean, and production departments. A total of 76 filled questionnaires were received giving a response rate of 30.4 %. Multiple responses were collected from the single organization as people have different views and opinions. So, each respondent was considered as individual case. The following research questions were developed:

RQ1: What is the perceived level of lean implementation in the textile companies of Pakistan?

RQ2: Is there any relationship between organization size and the implementation of lean practices in the textile companies of Pakistan?

RQ3: Is there any relationship between the type of textile companies and implementation of lean practices?

RQ4: Is there any relationship between the age of organization and implementation of lean practices?

RQ5: What is the current lean manufacturing system status in lean, in-transition, and non-lean textile companies?

RQ6: What are the major barriers faced by the textile companies while implementing the lean production philosophy?

The companies were divided into four groups based on their age i.e. the number of years since establishment:

- New (less than 10 years)
- Intermediate (10-20 years)
- Intermediate (21-30 years)
- Old (more than 30 years)

The companies were divided into four groups based on their size i.e. the number of employees:

- Small (<500 employees)
- Medium (501-1000 employees)
- Medium (1001-1500 employees)
- Large (>1500 employees)

There were six types of textile units identified:

- Spinning
- Weaving
- Knit wear
- Garments
- Vertical
- Other

IV. DATA COLLECTION AND ANALYSIS

RQ1: What is the perceived level of lean implementation in the textile companies of Pakistan?

The main driver that pushes the company to change to lean system is the organization's continual improvement program. The results are shown in Fig. 1.

Fig. 1. Driving forces to Lean Production

Different companies gain different benefits after practicing lean production techniques. The highest benefit reported by the sample companies is the cost reduction. Cost reduction is crucial for the applicability of lean practices and for the survival of the organizations [7, 26]. The results are shown in Fig. 2.

Fig. 2. Benefits of lean manufacturing

Among tools and techniques 5S, quality control circles, kaizen, and SMED are used extensively. The results are shown in Fig. 3.

Fig. 3. Distribution of responses based on the adoption of process and equipment related practices

Most of the respondents of sample companies are not aware of the term manufacturing planning and control, visual control, kanban, and levelled production. Consequently, these tools, techniques and practices are least used. Team effort and specialized and cross-functional training were perceived to be crucial to effectively implement lean. Most of the sample companies give importance to the long term relationship with suppliers and show commitment that suppliers consistently deliver quality. Similarly, customer satisfaction and on-time delivery to the customer is considered crucial.

RQ2: Is there any relationship between organization size and the implementation of lean practices in the textile companies of Pakistan?

The level of implementation is categorized into three categories: good, fair, and poor. From Table I it is concluded that the larger organizations used more lean manufacturing practices than smaller or medium sized organizations. As the number of employees increases, the percentage of lean manufacturing practices also increases. In larger firms, 22.2% firms have poor implementation of lean practices while 80.0 % firms have fair implementation and 83.8% firms showing good implementation level of lean manufacturing practices. It is also shown that 33.3% and 44.4% medium sized firms having poor implementation of lean production practices while the 6.7% and 6.7% have fair level of implementation and 2.7% and 5.4 % medium sized firms shows good level of lean manufacturing practices implementation. While 0.0% small firms have poor implementation, 6.7 % fair implementation, and 8.1% have good application of lean implementation.

TABLE I. The relationship between the size of the company and lean manufacturing implementation

			Number of employees				Total
			<500	**501-1000**	**1001-1500**	**>1500**	
Lean Manufacturing Implementation	Poor Implementation	Count	**0**	**3**	**4**	**2**	**9**
		% within Lean Production Implementation	0.0%	33.3%	44.4%	22.2%	100.0%
		% within Number of employees	0.0%	50.0%	50.0%	3.5%	11.8%
		% of Total	0.0%	3.9%	5.3%	2.6%	11.8%
	Fair Implementation	Count	2	2	2	24	30
		% within Lean Production Implementation	6.7%	6.7%	6.7%	80.0%	100.0%
		% within Number of employees	40.0%	33.3%	25.0%	42.1%	39.5%
		% of Total	2.6%	2.6%	2.6%	31.6%	39.5%
	Good Implementation	Count	3	1	2	31	37
		% within Lean Production Implementation	8.1%	2.7%	5.4%	83.8%	100.0%
		% within Number of employees	60.0%	16.7%	25.0%	54.4%	48.7%
		% of Total	3.9%	1.3%	2.6%	40.8%	48.7%
Total		Count	5	6	8	57	76
		% within Lean Production Implementation	6.6%	7.9%	10.5%	75.0%	100.0%
		% within Number of employees	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	6.6%	7.9%	10.5%	75.0%	100.0%

From the endnote of the Table II, it is concluded that 75 % cells have expected count less than 5. Therefore, the results indicates that the differences in lean manufacturing implementation across the different sizes of the textile companies is statistically significant ($\chi 2$ = 24.428, p = 000, df = 6) – there is a significant relationship between the implementation of lean manufacturing and the size of the company.

TABLE II. The results of Chi-Square test on the relationship between the size of the company and lean manufacturing implementation

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	24.428a	6	.000
Likelihood Ratio	19.258	6	.004
Linear-by-Linear Association	3.380	1	.066
N of Valid Cases	76		

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .59.

RQ3: Is there any relationship between the type of textile companies and implementation of lean practices in Pakistan?

Table III indicates that the difference in implementing lean manufacturing practices across different types of textile companies is statistically significant ($\chi 2$ = 22.483, p = 0.013, df = 10). There is a relationship between the implementation of lean manufacturing practices and type of textile company.

TABLE III. The results of the Chi-Square test on the relationship between lean production practices and the types of company

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.483a	10	.013
Likelihood Ratio	26.152	10	.004
Linear-by-Linear Association	.425	1	.515
N of Valid Cases	76		

a. 12 cells (66.7%) have expected count less than 5. The minimum expected count is .36.

RQ4: Is there any relationship between the age of organization and in implementation of lean practices?

On the basis of the literature review, it is concluded that age and lean implementation are negatively correlated i.e. older the organization lesser the lean implementation because it's difficult for the organization to change production system and organizational culture. However, this study did not yield a significant relationship between these two factors. The overall results from the Table IV shows that the value of the Pearson Chi-Square is 7.677 at significance level of 0.263, indicating that the results are not significant. There is no relationship between the age of the company and the implementation of lean manufacturing.

TABLE IV. The results of Chi-Square test on the relationship between the size of the company and lean manufacturing implementation

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.677a	6	.263
Likelihood Ratio	8.083	6	.232
Linear-by-Linear Association	1.494	1	.222
N of Valid Cases	76		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is .59.

RQ5: What is the current lean manufacturing system status in lean, in-transition, and non-lean textile companies?

In order to identify the lean manufacturing status cluster analysis was used. Cluster analysis is an exploratory data analysis tool for identifying homogenous groups of objects called clusters. Objects (or cases, observations, companies, people, things) in a specific cluster share many characteristics (maximizing the similarity of cases within each cluster) while are very dissimilar to objects not belonging to that cluster (maximizing the dissimilarity between groups that are initially unknown).

Clustering variables were categorized into five: Process and equipment, manufacturing planning and control, human resources, supplier relationships and customer relationships. Cluster analysis is computed from the average values of the lean practices variables for all the respondents and indicates the extent of the lean manufacturing implementation according to their lean status. The same method is used by Panizzolo [25] in his research to identify the factors that differentiate the firms and also used by Shah & Ward [16] and Norani, et al. [24].

Using a hierarchical cluster analysis, three clusters were identified. These three cluster groups are named as lean, in-transition (towards lean), and non-lean according to their mean values. First, lean group (A) has 22 companies and is categorized as lean group because these companies are having highest mean score of all the lean manufacturing tools, techniques, and practices used in this survey. The second group (B) is in transition, having 43 companies and these companies have the moderate mean scores of the all variables. Finally, the non-lean group (C), which has 11 companies, is classified as non-lean because of low mean scores of all variables.

It is concluded that all groups (A, B, C) are focusing on building suppliers and customers relationships. Group (A) i.e. lean firms are emphasizing on human resource and spend resources on process and equipment while little focus is given to manufacturing planning and control. Group (B) is on moderate level of implementation and focuses on human resource while group (C) just concentrates on building good relations with supplier and with customers. So the least implemented lean manufacturing practices in all groups is manufacturing planning and control.

TABLE V. Mean values for three clusters

	Lean (A) **n=22** **28.9 %**	**In-transition (B)** **n=43** **56.6%**	**Non Lean (C)** **n=11** **14.5%** **n= number of companies** **%= companies Percentage**
Process and equipment	3.2934	2.8647	1.6364
Manufacturing process and control	2.8977	2.3721	1.4318
Human resources	3.6667	3.1059	1.8081
Supplier relationship	3.1023	3.4244	3.0227
Customer relationship	4.0303	3.8605	3.3333

Table V shows that lean cluster (A) has shown higher mean scores in all lean production practices than the other two groups and non-lean cluster (C) has the lowest mean scores. As a result, these findings are consistent with the known theory that lean cluster have significantly higher mean practices.

In order to check the statistical significance of the difference in five variables across the three cluster groups, ANOVA test was conducted.

In order to examine whether the cluster means are the same, they can be represented by the F-ratio for the combined effect between-group. Table VI shows the results of ANOVA. It shows significant effect of clustering variables on the cluster groups except for suppliers and customers relationship.

TABLE VI. ANOVA results for testing significance between cluster means

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Process & Equipment	Between Groups	20.421	2	10.210	27.062	.000
	Within Groups	27.542	73	.377		
	Total	47.963	75			
Manufacturing Planning and control	Between Groups	15.784	2	7.892	12.386	.000
	Within Groups	46.515	73	.637		
	Total	62.299	75			
Human Resource	Between Groups	25.396	2	12.698	24.747	.000
	Within Groups	37.458	73	.513		
	Total	62.854	75			
Suppliers Relationship	Between Groups	2.316	2	1.158	2.009	.141
	Within Groups	42.081	73	.576		
	Total	44.397	75			
Customer Relationship	Between Groups	3.635	2	1.818	2.762	.070
	Within Groups	48.031	73	.658		
	Total	51.667	75			

DISCRIMINANT ANALYSIS

Discriminant analysis was also used for cross-validating the results of cluster analysis and provide the best discrimination between groups. A discriminate function was derived by linear combination of the five clustering variables. The discriminant is achieved by setting the weight of each of the variables to maximize the between-group variance relative to the within-group variance. Discriminant is most effective when having a relationship between categorical and continuous values.

The larger the eigenvalue, the more of the variance in the dependent variable is explained by independent variable. The canonical correlation is the measure of association between the discriminant function and the dependent variable. Wilks' lambda is a measure of how well each function separates cases into groups. So, smaller values of Wilks' lambda indicate greater discriminatory ability of the function. The Table VII shows two discriminant functions from findings. The first discriminant function explained 93.2% variance, canonical correlation of 0.713, whereas the second explained 6.8 % of variance and canonical correlation of 0.266. So that, these two discriminate functions significantly differentiated the cluster groups ($p < 0.05$), but removing the first function indicated that the second function did not significantly differentiate the cluster groups.

TABLE VII. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.037a	93.2	93.2	.713
2	.076a	6.8	100.0	.266

a. First 2 canonical discriminant functions were used in the analysis.

TABLE VIII. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	.456	55.696	10	.000
2	.929	5.194	4	.268

In structure matrix Table IX, the correlations between the outcomes and the discriminant functions revealed all the clustering variables were loaded fairly higher in first function, whereas suppliers relationship was loaded higher in second function than the first function.

TABLE IX. Structure Matrix

	Function	
	1	2
Process & Equipment	.841*	.315
Human Resource	.808*	.098
Manufacturing Planning and control	.571*	-.122
Customer Relationship	.268*	.124
Suppliers Relationship	.037	.841*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions
Variables ordered by absolute size of correlation within function.

*. Largest absolute correlation between each variable and any discriminant function

RQ6: What are the major barriers faced by the textile companies while implementing the lean manufacturing philosophy?

Based on the literature review, ten factors that resist implementation were identified and included in the questionnaire. Frequency table and charts were used to analyze the data. From Table X, it is indicated that in non-lean firms, the four main barriers are: the employee resistance, lack of communication, company culture, and lack of understanding. On the other hand, the firms which are in transition towards lean manufacturing system the company culture, employee resistance, lack of communication and the lack of understanding to implement lean manufacturing are major factors. Again for the lean firms, lack of communication is identified as the main barrier to implement lean manufacturing system successfully. The results are also shown in Fig. 4.

TABLE X. Barriers faced by Pakistani textile companies in the implementation of lean manufacturing

Sr. No.	Lean barriers	Mean Score			
		In Transition	Lean	Non Lean	Total
1	Company Culture	3.3256	2.0909	3.9091	3.0526
2	Lack of top management commitment	2.3256	2.3256	2.9091	2.3026
3	Attitude of middle Management	2.7209	2.7273	2.8182	2.7368
4	Lack of communication	3.0233	3.3636	4.0000	3.2237
5	Employee resistance	3.3023	2.6364	4.0909	3.2237
6	Back sliding to the old ways of working	2.3023	1.8636	3.3636	2.3289
7	Lack of time to Implement	2.7674	2.2727	3.6364	2.7500
8	Lack of understanding to implement lean manufacturing concepts	2.9535	2.1364	3.9091	2.8553
9	Budgets constraints	2.2093	2.3182	3.5455	2.4342
10	Failure of past lean project gets constraints	1.6279	1.1818	1.6364	1.5000

Fig. 4. Barriers faced by pakistani textile companies in the implementation of lean manufacturing

V. DISCUSSION

The findings of the study show that the lean manufacturing is not implemented effectively in textile sector of Pakistan. This sector lacks understanding of lean manufacturing concepts and therefore have not reaped the full benefits of lean implementation. Most companies only focus on a few tools and techniques neglecting others. For example, 5S (housekeeping) is extensively used while manufacturing planning and control is used rarely.

The textile companies in Pakistan need a focused training on lean manufacturing to enable its better understanding. They need to implement lean practices in all areas of manufacturing (especially in area of manufacturing planning and control). There is lack of understanding of lean manufacturing practices. Industries have not employed a systematic approach in lean implementation.

Another important element for the successful lean implementation is the top management commitment for cultural transformation. They need to invest in training of employees and make sure employees are involved in the whole process. As employees show resistance to change so attention should be given to change their mind set. Incentives should be given to the workers for their support. The benefits of lean must be shared among all stakeholders.

It is recommended for future research to concentrate on single unit (spinning, weaving, knit wearing, and garment) of textile rather than overall sector. This will provide better understanding of lean performance in a specific type of unit.

The companies should be encouraged to benchmark their system with the world class firms. This can help bring rapid improvements in their performance. Gap analysis should be performed between Pakistan and other countries that are having well established lean system, in order to identify the performance gap.

As the data were collected through questionnaire and were based on the perception of the respondents. This was not supported by any secondary data from any other organizational source and no instrument was available to gauge the exact situation that exists in sample companies. Therefore, future research should be based on detailed investigation through interviews, documents review, observations and qualitative approaches to generalize the results of this study.

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