Assessment of Lean Initiatives : An Investigation in the Indian Apparel Export Industry

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Abstract

Lean is a philosophy of continuous development, and making the evaluation of its effects on a business against the expected value-adds further assists the business managers to make strategic decisions on the adoption of new productivity improvement initiatives. The present study was designed to comparatively assess the status of the lean initiatives among lean initiated and non-lean initiated apparel units. The study was limited to 10 selected lean initiated and non - lean initiated apparel units, each manufacturing ladies garments in the National Capital Region (India) using inclusion and exclusion criteria from the member list of Apparel Export Promotion Council, Gurgaon, India. The status was evaluated on the basis of seven lean bundles formed by combining 33 lean enterprise practices and using six- stage assessment matrix from the traditional to world class on the basis of the total scores obtained. The result revealed that most of the lean initiated apparel units were at the planning, learning, initiation, and improving stage that is phase I or II, while only one unit was found to be at phase III, that is, at extensive lean introduction and results visibility phase and had a long way to go towards complete transformation. Still, a significant difference was found in the current status of lean initiatives among lean initiated and non-lean initiated apparel units. The lean assessment matrix developed can also be used by other apparel manufacturing units actively engaged in their lean journey to benchmark themselves against the "best in class" lean standard.

Keywords : lean assessment matrix, leadership and culture, workforce orientation, 5S and visual management, total productive maintenance

JEL Classification: L23, M11, M54

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"Everyone is somewhere on the journey to become Lean; no one has yet arrived."

Wilson (2010, p.210)

Lean manufacturing is a continuous, long term process and a commitment stretching over months to years. Hence, transformation into to a complete lean enterprise can take even up to 40 years. Its implementation involves flexible adoption of lean tools, techniques and culture in a general sequence, the degrees to which they overlap and interconnect depends on each manufacturing unit's circumstances and the skill, and experience of its chosen lean guide or consultant. In order to continuously motivate the workers as well as help the business managers or owners to make strategic decisions on the adoption of new productivity improvement initiatives, it is

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Table 1. Overview of Lean Tools and Techniques

S.No.	Lean Tools and Techniques	Description
1.	5S	Workplace organization and management.
2.	Visual Management(VM)	Visual Control for exceptional management.
3.	Andon	Warn of pending problems in the system.
4.	Kaizen	Continuous improvement.
5.	Kanban & Pull System	Trigger mechanism for flow and pull.
6.	Value Stream Mapping(VSM)	Optimizing Value added works.
7.	Poka Yoke	Mistake Proofing.
8.	Heijunka	Workflow levelling by volume & variety.
9.	One Piece Flow/Just In Time(JIT)	Single piece flow as per takt time
10.	Takt Time	Rate of customer demand.
11.	Total Productive Maintenance(TPM)	Preventive, predictive & autonomous.
12.	Cellular manufacturing	Group of workstations, machines & equipment efficiently arranged with people being central.
13.	Single Minute Exchange of Dies(SMED)	Quick changeover & setup reduction.
14.	Team Work & Workforce Empowerment	Working together as team, and using their knowledge to solve problems.
15.	Problem Solving Techniques	Root cause analysis through ishikawa ,5 whys and so forth.
16.	Standard Operating Procedure(SOP)	Use of stable, repeatable methods.
17.	Jidoka	Problems identified and eliminated at the source.

Note. Adapted from Bannari & Dhanakodi(2010);Hallam(2003); and Mekong Capital(2004).

important to continuously measure progress and assess the status of implementation of various elements of lean.

Lean has a set of lean 'tools' and techniques that assist in the identification and steady elimination of waste (Muda), the improvement of the quality, reduction in production time and costs. The perfect lean unit represents a state of continuous flow that requires these Toyota production system tools to operate effectively. Tools like continuous process improvement (Kaizen), the '5 Whys' and mistake proofing (poka-yoke) helps to solve the problem of waste, while, Kanban and Heijunka techniques are used to implementing the 'flow' or smoothness of work(IFS R&D,2004). It focuses on creating a continual improvement of culture that engages the employees in reducing the intensity of time, materials and capital necessary for meeting the customer's need (Farhana & Amir, 2009).Lean tools and techniques are given in Table 1.

Objectives of the Study

Keeping the importance of measuring progress made in an effort to become lean, this study was planned with the following objectives :
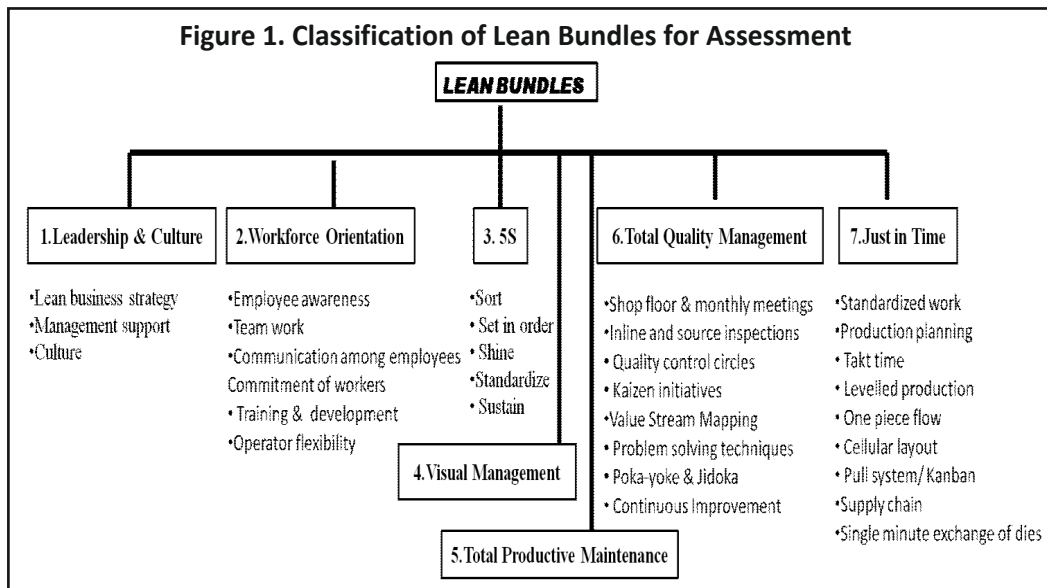
(i) To assess the status of lean initiatives in apparel manufacturing units in the National Capital Region (NCR) in India.

(ii) To comparatively analyze the lean initiation status between lean initiated and non-lean initiated apparel units.

(iii) To examine the relationship between individual lean assessment bundles and total lean assessment score.

Methodology

The study was confined to the apparel units in National Capital Region (NCR) in India. Ten lean initiated and non-lean initiated apparel units each were selected using inclusion and exclusion criteria from the member list of Apparel Export Promotion Council (AEPC), Gurgaon, India (8195 members). Member units in National capital region which were manufacturing or manufacturing cum merchant exporters were included and all the rest were excluded. Out of the 1010 selected units, ones engaged in assembly line and manufacturing ladies wear were further included. It was found that out of 205 units, only 21 apparel units were practicing lean, and hence all of these apparel units were contacted through local associations like Okhla Garment Textile Cluster (OGTC) and Noida Garment manufacturing Association. Only 10 Lean initiated units agreed to provide the details and information required for the study, as well as allowed firsthand experience of lean implementation through personal visits to various departments of the apparel manufacturing units. The time period of the study is from June 2012 - January 2013.

For comparison, 10 non- lean initiated apparel units were randomly selected using lottery method from the 184 non-lean initiated apparel units. Firstly, each apparel unit was assigned a unique number. These numbers were written on separate cards which were physically similar in shape, size, and colour. They were put in the basket and thoroughly mixed and the slips were taken out randomly without looking at them. The small sample was considered appropriate for this study as most of the apparel units were not very willing to allow the investigation into the status of lean initiation in their units due to confidentiality issues. Hence, cooperation offered and interest shown by them to participate was the main criterion to select the sample. As this research was a public document, it was agreed to refer each apparel unit by alphabets due to the confidential issues, alphabets A to J were used for 10 lean initiated units and alphabets K to T were used for 10 non-lean initiated units.

The field study method was also used for the in-depth study. A lean assessment checklist was made and used during the visit to each unit to determine their current lean status. These apparel units were first contacted by phone, then by a follow-up email in order to set up an initial face-to-face meeting at their facility. Personal interviews and visits to these apparel units enabled the researcher to carry-out the direct observation of the application of lean principles within a particular apparel unit and it also helped to identify some of the best practices in lean manufacturing. The observation method was also used to support the understanding of the general working environment and implementation of lean in each department in terms of the involvement of

Figure 1. Classification of Lean Bundles for Assessment

Table 2. Lean Assessment Matrix

Phases	Name	Description	Scores
Non -Lean	No Implementation/ Struggling/Traditional	Minimal Lean awareness, Yet to introduce lean principles. Poor results, most key metrics show negative trend	0-41
Phase-I	The planning& initiation stage/ Learning	Some awareness of the Lean concept, sporadic improvement activities may be underway in few areas.	42-82
Phase-II	The early phase/ Improving	Lean Orientation of workforce & Management; General awareness and openness to change; informal approach deployed in few areas with varying degrees of effectiveness and sustainment. Launched pilot projects and achieved some positive results	83 -107
Phase-III	Extensive introduction /Results visible	A systematic approach /methodology deployed in varying stages across most areas achieving solid progress measured in terms of metrics; good sustainment	108-133
Phase-IV	Adv implementation/ Leading	Almost all employees abide by & act according to lean principles. On-going refinement and continuous improvement across the enterprise; improvement gains are sustained.	134-150
Phase-V	Lean Enterprise/ Benchmark/ Recognized Best Practice/ World Class	Exceptional, well defined, innovative, continuous improvement approach is fully deployed across the extended enterprise (across internal and external value stream) recognized as best practice.	151-165

Note. Data for lean assessment phase criteria's adapted from Bentley (2007) and Buehle (2008).

workers in kaizen initiatives, and various lean criterias.

The lean assessment tool was developed and used as a means for measuring the current status of leanness of the organization and evaluation of the implementation of each lean technique through directed interviews and site visits. The data regarding apparel unit's current extent of lean implementation was collected using an assessment matrix which was adapted from the AME Lean Assessment Schedule, ABC Company, Toronto (Association for Manufacturing Excellence [AME], 2008).This assessment tool was based on Kobayashi's 20 keys (n.d.) to workplace improvement and LESTAT Lean assessment tool (Nightingale, 2005) that gives a sense as to at which stage the company is in its lean journey. Each tool was split by specific elements essential for successful implementation. The assessment began with 33 lean items.

Thirty three lean enterprise practices were combined into 7 lean bundles on the basis of similar goals as shown in Figure 1. Each item had 6 levels, each of which described the environment at that level. The description made the rating for each item easier and more consistent across the multiple respondents. Accordingly, each item was rated on the 6 point likert scale to measure the extent of implementation .The scale was ranged from 0 to 5 where weights were attached to different levels of lean initiation. Weight 0 was attached to Baseline, 1 to Beginner, 2 to Basic , 3 to Visual, 4 to Systematic and 5 to Completely. There was a practice definition for every initiation level in every practice, provided on a matrix assessment sheet.

We filled the questionnaire-cum-interview schedule after observation, with interview of industrial engineer and field visit of the apparel unit. Data was also substantiated with constant interaction held with the officials and workers on the shop floor and the proof in the form of photos and videos were collected. Then the ratings were totaled and on the basis of score obtained, phase of lean initiatives was decided. Present phase or status of lean implementation of the apparel units were found using 6- stage assessment matrix (Table 2) from traditional to world class on the basis of the scores obtained.

Experts from the industries and academicians who had long experience in transforming organizations into lean enterprises were also consulted to check the suitability of the research instrument. The comments and feedback were analyzed and a few minor modifications were made especially in the questionnaire format. It was

Figure 2. Bar Graph Showing the Distribution on the Basis of Phase of Lean Initiation
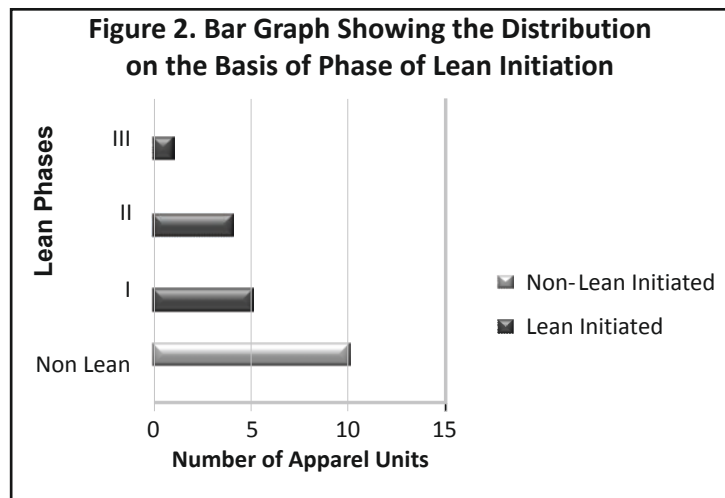
Table 3. Distribution of Respondents on the Basis of Phase of Lean Initiation in Association with Lean Awareness, Year of Lean Initiation, and Adoption of Lean Tools and Techniques

S.No.	Attributes	Options	Phase of Lean Assessment			
			Non Lean f(%)	I f(%)	II f(%)	III f(%)
(i)	Extent of Lean Awareness	Not at All	4(40)	0(0)	0(0)	0(0)
		Slightly	3(30)	0(0)	0(0)	0(0)
		Moderately	3(30)	1(20)	0(0)	0(0)
		Very	0(0)	4(80)	0(0)	0(0)
		Extremely	0(0)	0(0)	4(100)	1(100)
(ii)	Year of Lean Initiation	Not Initiated	10(100)	0(0)	0(0)	0(0)
		≤ 2 years	0(0)	5(100)	0(0)	0(0)
		>2 years	0(0)	0(0)	4(100)	1(100)
(iii)	Tools & Techniques Used	Not Adopted	10(100)	0(0)	0(0)	0(0)
		5S	0(0)	5(100)	4(100)	1(100)
		Visual Management	0(0)	5(100)	4(100)	1(100)
		Value Stream Mapping	0(0)	2(40)	4(100)	1(100)
		Kaizen	0(0)	5(100)	4(100)	1(100)
		Andon	0(0)	1(20)	2(50)	1(100)
		Just in Time(JIT)	0(0)	0(0)	0(0)	1(100)
		Poka Yoke	0(0)	1(20)	4(100)	1(100)
		Kanban & Pull	0(0)	0(0)	0(0)	1(100)
		Heijunka	0(0)	0(0)	3(75)	1(100)
		One Piece Flow	0(0)	0(0)	0(0)	1(100)
		Total Productive Maintenance	0(0)	0(0)	0(0)	1(100)
		Cellular manufacturing	0(0)	1(20)	4(100)	1(100)
		Single Minute Exchange of Dies	0(0)	0(0)	2(50)	1(100)
		Workforce Orientation	0(0)	1(20)	4(100)	1(100)
		Problem Solving Techniques	0(0)	1(20)	4(100)	1(100)
		Standardized Work	0(0)	1(20)	4(100)	1(100)

tested and modified after the pilot study. Though Pakdil and Leonard (2014) had also developed leanness assessment tool (LAT) to assess the effectiveness and efficiency of the lean implementation in any business firms but the assessment matrix developed in this research was specifically developed as per the industry and country scenario.
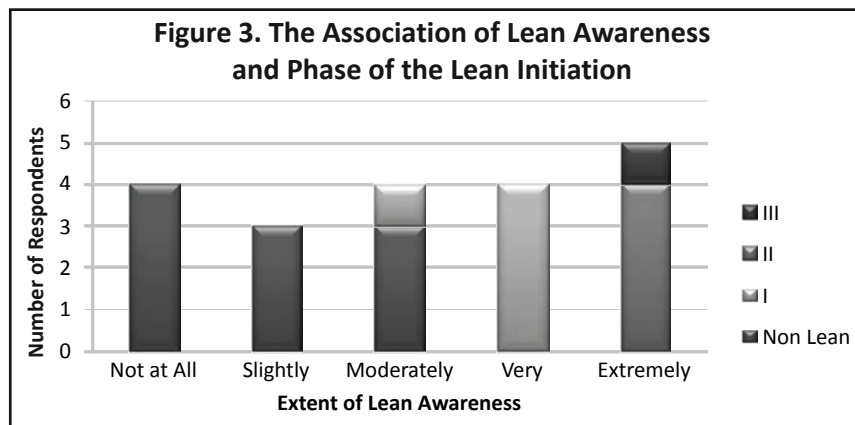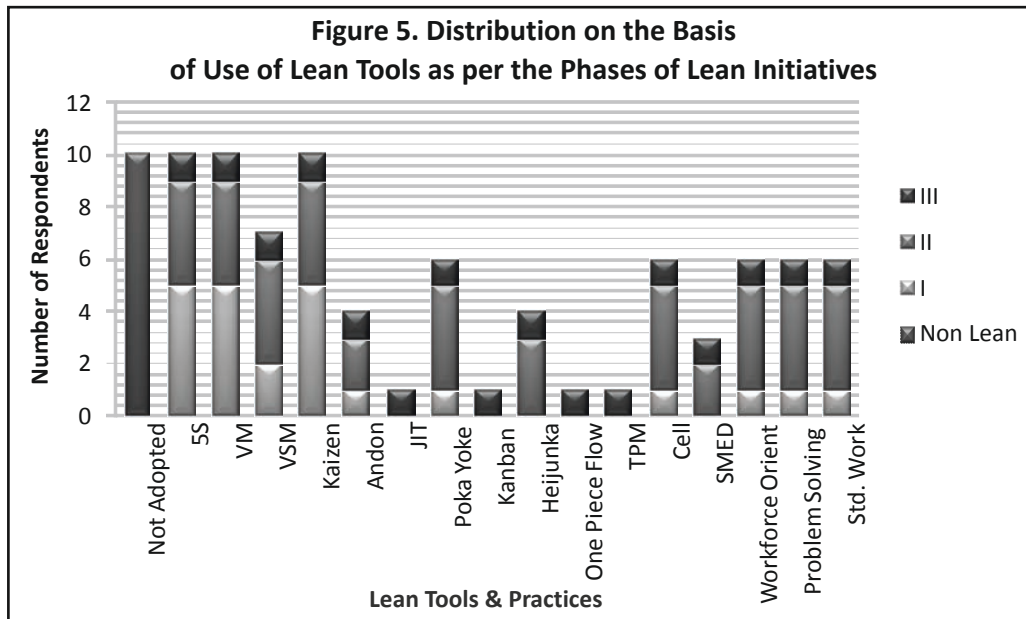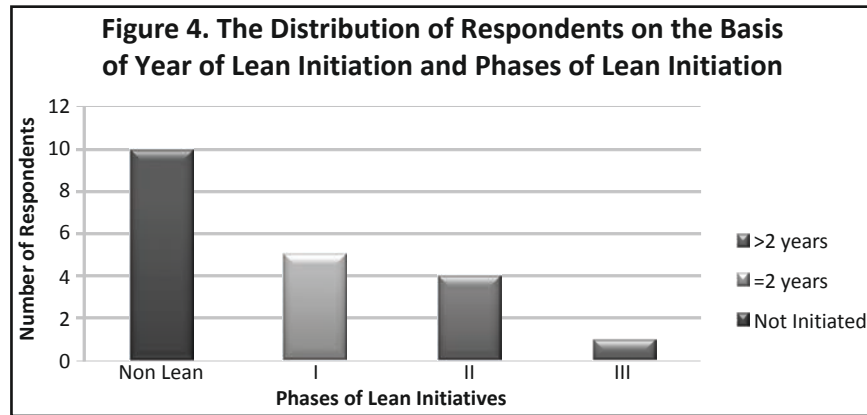
Results and Discussion

The analysis of the assessment of lean initiatives in 20 apparel units is given below.

The Figure 2 indicated that all the non- lean initiated units were at *non-lean* phase and were traditional in their working. They had the minimal lean awareness and had not introduced lean principles. They generally struggled in order to meet their 'order to shipment' deadlines, showing poor results and negative trends in most of their key metrics. Fifty percent of the lean initiated units respondents were at *phase I* that is at the planning, learning and initiation stage. These units had some awareness of the lean concept and some sporadic improvement activities were underway in few areas. Highly noticeable proportion of respondents were at *phase II* that is the early phase or improving. In these units, lean orientation of workforce and management; and general awareness and openness to change was observed. Informal approach was deployed in few areas with varying degrees of effectiveness and sustainment. Various pilot projects were launched and positive results were achieved. Only one lean initiated unit was at *phase III* that is at extensive lean introduction and results visibility phase. This unit had adopted the systematic approach or methodology in varying stages across most areas achieving solid progress and good sustainment which was measured in terms of metrics.

Analysis of the Table 3 revealed that the 5 apparel manufacturing units which were extremely aware of the lean concept had initiated lean, and the 4 units were at phase II and only one unit was at phase III of lean initiatives. Four apparel units which were very aware of lean concepts were at phase I of lean initiation. Four units which were not aware of the concept at all had not initiated lean in their manufacturing units. Figure 3 shows the association of lean awareness and phases of their lean initiation. It was concluded that the apparel unit which were at phase III were more aware of the lean concepts in comparison to the units which were at phase I or II. The overall result was in line with the findings of the Kumar and Naidu (2012) stating that the status of lean implementation in the garment sector was still in its infancy stage and only 4% were found practicing lean tools.

The year of lean initiation also seems to have an effect on the phase of lean initiation as shown in the Table 3 and diagrammatically represented in the Figure 4. Out of the five units which had initiated lean since *more than 2 years*, four were at phase II and only one was at Phase III of lean initiation. Five units which had initiated lean in the *last 2 years* were at phase I, while 10 units which had *not initiated lean* were at the non-lean phase. It was concluded that the units which had initiated lean earlier were at higher phase in comparison to apparel units which had initiated lean recently.

Figure 3. The Association of Lean Awareness and Phase of the Lean Initiation

Figure 4. The Distribution of Respondents on the Basis of Year of Lean Initiation and Phases of Lean Initiation

Figure 5. Distribution on the Basis of Use of Lean Tools as per the Phases of Lean Initiatives

As the Table 3 and Figure 5 indicate that upto 16 lean tools and practices were adopted by units which were at phase III of lean initiation. Maximum 12 tools were adopted by apparel manufacturing units which were at phase II, while, maximum 10 tools were adopted by the units at phase I. It was concluded that the phase of lean initiation has a positive relationship with the number of tools implemented. The implementation of number of tools increase as the apparel unit moves from phase I to phase III of lean initiation. The result was in concurrence with the findings of Fricke (2010) that the lean maturity determines the intensity with which the lean tools were implemented as at level four, the entire set of lean tools was implemented.
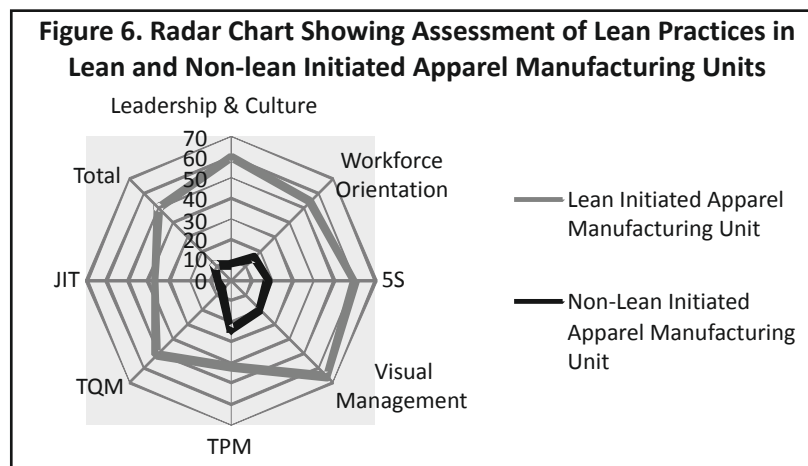
The average score and percentage of lean assessment of the lean and non-lean initiated apparel units are shown in the Table 4 and Figure 6. High score of the 82.7 was obtained by the those lean initiated units which had adopted most of the tools and practices well and were continuously making an effort towards improvement, but, still had a long way to go. Fair majority of the lean initiated units(66%) had implemented Visual Management quite well while 60% of the respondent units obtained high scores in 5S and Leadership and Culture followed by Workforce Orientation, Total Quality Management(TQM) and Total Productive Maintenance. Least score of 37% was obtained for Just in Time. While assessing these units, researcher observed that fair majority of the these units had a progressive and committed leadership, understanding of the importance of continuous improvement culture, awareness and practice of workplace organization, visual displays, markings and control of normal and abnormal

Table 4. Assessment of Lean Practices in Lean and Non-Lean Initiated Apparel Manufacturing Units

Assessment Criteria's	Lean Initiated Apparel Manufacturing Units		Non-Lean Initiated Apparel Manufacturing Units	
	Avg. Scores	Avg. %	Avg. Scores	Avg. %
Leadership & Culture	9	60	1.2	8
Workforce Orientation	16.2	54	4.8	16
5S	14.9	60	4.4	18
Visual Management	3.3	66	1	20
Total Productive Maintenance	2.1	42	1.2	24
Total Quality Management	20.4	51	2.4	6
Just in Time	16.8	37	2.5	6
Total	82.7	50	17.5	11

Note. *N* = 20 Total (10 Lean & 10 Non-Lean)

Figure 6. Radar Chart Showing Assessment of Lean Practices in Lean and Non-lean Initiated Apparel Manufacturing Units

Table 5. Current Level of Leadership and Culture in Lean and Non-Lean Initiated Apparel Manufacturing Units

Assessment Criteria's	Lean Initiated Apparel Manufacturing Units		Non-Lean Initiated Apparel Manufacturing Units	
	Avg. Scores	Avg. %	Avg. Scores	Avg. %
Lean Business Strategy	3.1	62	0.4	8
Management Support	3.1	62	0.5	10
Culture	2.8	56	0.3	6
Total	9	60	1.2	8

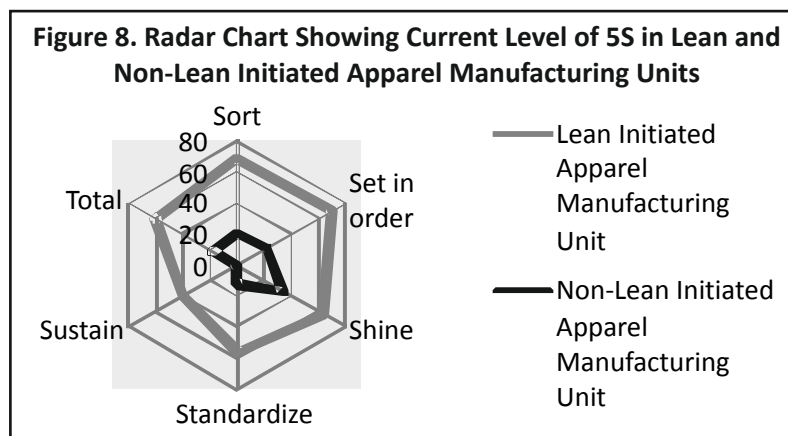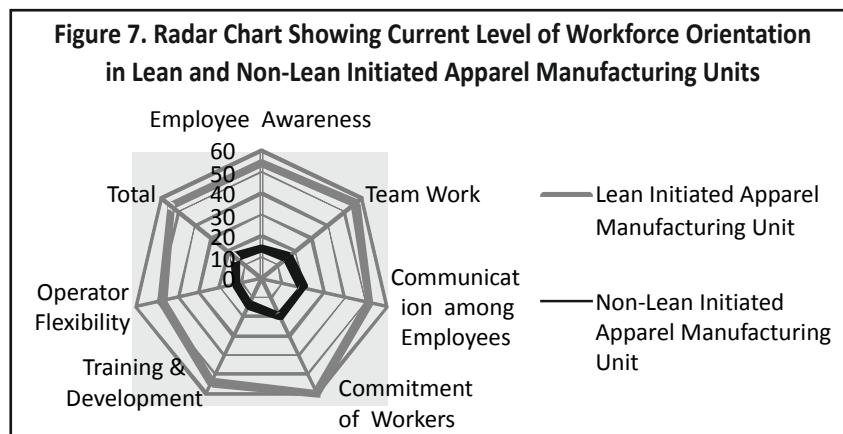Note. *N* = 20 Total (10 Lean & 10 Non-Lean)

in the work area. Majority of these units had employees who were aware of the goals of their units and took initiatives to lead improvement projects using problem solving techniques and worked continuously towards producing garments right first time. Highly noticeable proportion of these units kept an accurate and visible maintenance record of the machines, tracked machine downtime used permanent corrective actions at the time of breakdown and regular audits to verify the effectiveness of maintenance standards. Noticeable proportion of these units understood and followed the concept of producing garments just in time of the demand with very less work in progress and inventory in between the processes. Low score of 17.5 obtained by non-lean initiated units

depicted that their various important elements of lean were at a very low level. It was concluded that lean initiated apparel units had adopted various lean practices to different extent in comparison to negligible adoption in non-lean initiated units.

Fair majority of lean initiated units had an in-formal lean strategy that is 62% and timeline implementation, formation and working of lean team and defined key performance metrics with management support and guidance. Majority of these units that is 56% had awareness regarding cultural issues and these changes were mainly addressed via communication and team meetings. The problems were also processed and informed to the employees. Efforts were made to create a progressive and open environment which would allow generation of new improvement ideas along with the encouragement of No blame game. Very low score of Leadership and Culture was obtained by non-lean initiated apparel units. Comparison of the total scores of Leadership and Culture of lean and non-lean initiated units revealed that it was adopted at a higher level in lean initiated apparel manufacturing units. The Table 5 shows the current level of Leadership and Culture in lean and non lean -initiated units.

Majority of the employees in the lean initiated units were the committed workers. Some were aware of the unit's vision and goals. They also understood the expectations of internal as well external customers. Team work was found prevalent in 56% of the lean initiated units where most of the employees worked individually towards a common goal. Excellent informal and formal communication was there throughout the unit both upward and inward as there were frequent meetings within and with other departments as well as with the management. Fifty four percent of the apparel units had done various training and worker upgradation programs planned throughout the year while in 48% units, operators were multi-skilled and their cross-skill training matrix existed and was

Figure 7. Radar Chart Showing Current Level of Workforce Orientation in Lean and Non-Lean Initiated Apparel Manufacturing Units

Figure 8. Radar Chart Showing Current Level of 5S in Lean and Non-Lean Initiated Apparel Manufacturing Units

posted visually. Job rotation as per the demand was commonly seen in the lean initiated units. All these workforces related practices were prevalent at a very low level among the non-lean initiated units depicting by a low score of 4.8.It was concluded that current level of Workforce Orientation was higher at 54% in lean initiated units in comparison to only 16% in non-lean initiated units. Figure 7 illustrates the current level of Workforce Orientation.

The Figure 8 highlights the current level of 5S in the lean and non-lean initiated units. The average score revealed that 70% had clearly indicated and dedicated positions for needed items, 68% of the respondents had maintained a red tag area for unneeded items, and 64% had regular cleaning of the area and equipment in the lean initiated units. Employees were given separate time to clean their work area and evidence of pride in cleaning among them was witnessed. Fifty six percent units had standard work layout posted and consistently used, while; only 40% units conducted 5S assessment or audits occasionally. It was concluded that these workplace arrangement and cleanliness 5S activities were prevalent at a very low level in non lean initiated units in comparison to lean initiated apparel manufacturing units.

Current level of Total Quality Management is evident from the Figure 9 in 62% of the lean initiated units; most workers understood not only the value of VSM but, also executed the mapping of the whole process with action plans & roles assigned. Sixty percent lean initiated apparel units conducted shop floor and monthly meetings frequently. In 58% lean initiated units, even though operators were conscious of the quality produced, still inline and end line checking was used to find defects. In 52% of lean initiated apparel units, there was policy regarding continuous improvement methods focusing on training as investment and preference to long term goals over short term goals and involvement of the employees'.

Fifty two percent of lean initiated units had moderate awareness regarding the usage of simple problem solving tools and used 5 why, spaghetti diagram, VSM, root cause analysis and cause and effect analysis to prioritize and address problems while 50 % lean initiated unit's had plans and implemented Kaizens once in two weeks and incentives were paid to encourage the use of suggestion system for idea generation. In 40% lean initiated units, defective pieces were detected immediately as it occurred in production area due to the installation of simple error proofing devices. Twenty eight percent of these units had quality control circles operating in one or two departments to solve problems. Low score of 2.3 in non-initiated apparel units depicted that such quality practices were being implemented at a very low level where as lean initiated units depicted a score of 20.4.It was concluded that level of adoption of these Total Quality Management (TQM) practices was higher in lean initiated units in comparison to non-lean initiated apparel manufacturing units.

Current level of Just in Time in most of the lean initiated apparel units were found to be below average as shown in Table 6. Forty four percent units had written standardized operation sequence for most of the operations after identification of value and non-value added steps. Noticeable proportion of units (34%) conducted weekly

Figure 9. Radar Chart Showing Current Level of Total Quality Management in Lean and Non-Lean Initiated Apparel Manufacturing Units
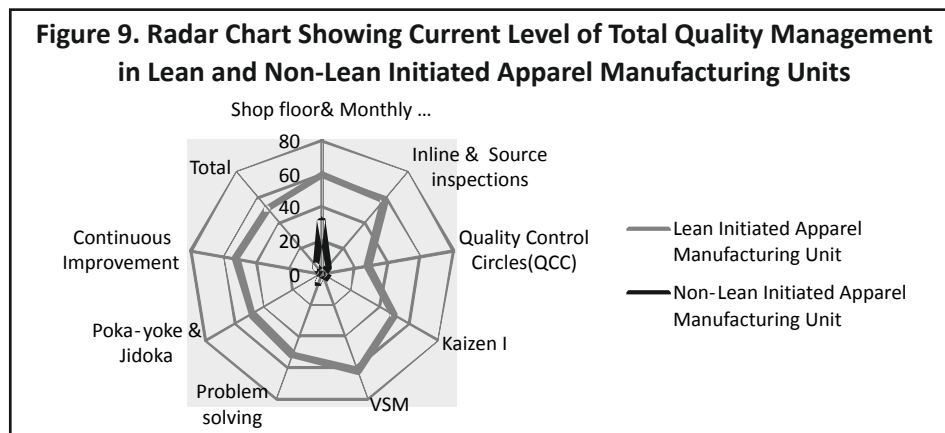
Table 6. Current Level of Just in Time in Lean and Non-Lean Initiated Apparel Manufacturing Units

N=20 Total (10 Lean & 10 Non-Lean)

Assessment Criteria's	Lean Initiated Apparel Manufacturing Units		Non-Lean Initiated Apparel Manufacturing Units	
	Avg. Scores	Avg. %	Avg. Score	Avg. %
Standardized work	2.2	44	0.5	10
Production Planning	1.7	34	1	20
Takt time	2	40	0	0
Levelled production	2.1	42	0	0
One piece flow	2.3	46	0.1	2
Cellular Layout	2.4	48	0.3	6
Pull system/Kanban	1.9	38	0.3	6
Changeover time & reduction	1.3	26	0	0
Supply chain	0.9	18	0.3	6
Total	16.8	37	2.5	6

Table 7. Mean, Standard Deviation, Correlation, and Mann-Whitney U Analysis of Lean Assessment Factors in Lean and Non-Lean Initiated Apparel Units

N=20(Lean=10 & Non-Lean=10)

Category	Lean Assessment factors											
	Leadership & Culture		Workforce Orientation		Visual Management		Total Productive Maintenance		Total Quality Management		Just in Time	
	Lean	Non-Lean	Lean	Non-Lean	Lean	Non-Lean	Lean	Non-Lean	Lean	Non-Lean	Lean	Non-Lean
M	8.28	1.20	14.91	4.80	3.36	1.00	2.36	1.20	19.09	2.40	15.9	2.50
SD	3.66	1.40	6.11	1.62	0.81	0.94	1.29	0.42	7.49	1.78	7.91	2.01
Mean Rank	15.59	5.95	15.14	6.45	15.64	5.90	14.00	7.70	15.95	5.55	16.00	5.50
Sum of Ranks	171.50	59.50	166.50	64.50	172.00	59.00	154.00	77.00	175.50	55.50	176.00	55.00
Mann-Whitney *U*	4.50		9.50		4.00		22.00		0.50		.0001	
U Test *p*-value	.000**		.001**		.000***		.020*		.000***		.000***	
ρs with lean ρs	.672		.626		.745		.544		.832		.794	
assessment score *p*-value	.001**		.003**		.000***		.013*		.000***		.000***	

Note. U= Mann-Whitney value ; ρs = Spearman correlation coefficient. *p*-value <0.001=***. *p*-value <0.01 =**. *p*-value <0.05=* .*p*- value >0.05 = ns.

production planning with calculation of takt time by 40 % units. Leveled production flow was seen in few departments; takt time was known, but, not utilized to its fullest extent. So large batches and excessive work in progress (WIP) still existed in most of the lean initiated units. Weeks' worth of pieces were stored in between the sewing line in 46% units while cell formation by clubbing various process steps after time study and   its documentation was practiced in 48% of the lean initiated units, where cross training of operators and such machine placements were done to promote flexible handling. Pull system was initiated via Kanban system in very few areas but first in first out (FIFO) was followed in most units. Only 26% units had awareness regarding setup time reduction and very few actually gave training to workers and reduced the changeover time of styles. Extension of pull to the supply chain was not visible in the lean initiated units with decisions primarily based on

forecast and price. Very few supplier metrics were known but were not communicated to the suppliers. It was concluded that such JIT practices were hardly prevalent in non-lean initiated apparel manufacturing units as these units had achieved an average score of 2.5 while lean initiated apparel units had achieved a total score of 16.8.

H$_a$: There is a significant difference in the lean initiation status between lean initiated and non-lean initiated apparel units.

The above stated hypothesis was set with an aim to test the difference in the level of implementation of all *33 Lean practices combined under seven* bundles in lean and non- lean initiated units. Each of the bundles was formed by adding the scores for each individual lean practice and these seven bundles formed the criteria for assessing status and phase of lean implementation. For testing the hypothesis, Mann-Whitney U Test was used. The Table 7 illustrates that the mean scores of each lean assessment bundle in lean initiated apparel manufacturing units was higher than in non-lean initiated apparel manufacturing units.

The Mann-Whitney U test was performed to find the significance in the difference of the mean scores of some lean assessment bundles namely Leadership and Culture ($U = 4.50$, $p = .000**$, $\alpha = .01$), Workforce Orientation ($U = 9.50$, $p = 001**$, $\alpha = .01$), Visual Management ($U = 4.00$, $p = .000**$, $\alpha = .01$), Total Productive Maintenance ($U = 22.00$, $p = .020*$, $\alpha = .05$), Total Quality Management ($U = .50$, $p = .000**$, $\alpha = .01$), and Just in Time ($U = .0001$, $p = .000**$, $\alpha = .01$) between lean and non-lean initiated apparel units, while *t*-test was used for 5S and total lean assessment score. The difference in the mean rank values of all lean assessment factors in lean and non-lean apparel units was found highly significant as $p < .05$. Average score of 19.09 and 2.40 of TQM was obtained by lean and non-lean initiated units respectively in comparison to 14.91 and 4.80 of Workforce Orientation. Hence the null hypothesis was rejected and alternate hypothesis was accepted stating that there is a significant difference in the current status of lean initiatives among lean initiated and non-lean initiated apparel units.

Spearman rank correlation analysis was conducted to examine whether there was a relationship between individual lean assessment bundles and total lean assessment score. Analyzing the Table 7, it was seen that all positive values of the correlation coefficients indicates that increase in lean assessment score correspond to increase in the individual lean bundle. The relationship between lean assessment score and Leadership and Culture ($\rho_s = .672**$, $p < .01$) and Workforce Orientation ($\rho_s = .626**$, $p < .01$) was found to be highly significant, linear and positive while that with Total Quality Management ($\rho_s = .832***$, $p < .001$), Visual Management

Table 8. Mean, Standard Deviation, Correlation, *t*-test Analysis of 5S, and Total Lean Assessment Score in Lean and Non-Lean Initiated Apparel Unit

	Category	Assessment Score			
		5S		Total lean Assessment Score	
		Lean	Non-Lean	Lean	Non-Lean
M		13.82	4.40	90.18	17.50
SD		5.93	1.26	35.16	7.43
t-test	*t*	4.91		6.39	
	df	18		18	
	p-value	.000***		.000***	
r with lean assessment score	*r*	.659		1	
	p-value	.002			

Note. *r* = Pearson's correlation coefficient; *t* = observed or calculated; *t*-test value; *df* =Degree of freedom; Sig. (2-tailed) = two- tailed *p*-value associated with the test. *p*-value <0.001=***. *p*-value <0.01 =**.*p*-value <0.05 = * . *p*-value>0.05=ns.

$(\rho_s = .745^{***}, p < .001)$ and Just in Time $(\rho_s = .794^{***}, p < .001)$ was highly significant, linear, very strong and positive at 1% significance level. The relationship of lean assessment score with Total Productive Maintenance was found significant, linear and positive at 5% significance level $(\rho_s = .544, p < .05)$.

Table 8 gives the details of the descriptive statistics of mean and standard deviation for the 5S and total assessment score and their t-test value. Results show that the mean score of 5S and total assessment score in lean initiated apparel units is higher in comparison to that in non- lean initiated apparel units. A t-test reveals that there is a statistically reliable difference between the mean of 5S as lean initiated apparel unit has $(M = 13.82, SD = 5.93)$ and non lean initiated unit has $(M = 4.40, SD = 1.26)$, $t(18) = 4.91, p = .000^{**}, \alpha = .01$. Also a statistically reliable difference was revealed by t-test between the mean of total lean assessment score as lean initiated apparel unit has $(M = 90.18, SD = 35.16)$ and non- lean initiated unit has $(M = 17.50, SD = 7.43)$, $t(18) = 6.39, p = .000^{**}$, $\alpha = .01$.

Pearson correlation analysis was conducted to examine whether there was a relationship between 5S and total lean assessment score. Highly significant p-value suggested that the relationship of lean assessment score with 5S was significant, linear and positive $(R = .659^{**}, p < .01)$. Hence H_0 was rejected and alternate hypothesis was accepted stating that there is a significant difference in the current status of lean initiatives among lean initiated and non-lean initiated apparel units.

Managerial Implications

The lean assessment matrix developed can also be used by other apparel manufacturing units actively engaged in their lean journey for future. The assessment would give an opportunity to the units to benchmark themselves against the "best in class" lean standard. It will enable the interested apparel unit's to make forecasts on the relative cost of lean projects upfront, anticipate lean benefits, and realize the degree of lean readiness.

Conclusion

To conclude, the assessment has shown that most of the lean initiated apparel units were at planning, learning, initiation and improving stage that is in phase I or II, while only one unit was found to be at phase III that is at extensive lean introduction and results visibility phase. All the non-lean initiated units were neither aware nor had initiated any lean practices. As most of the apparel units had initiated lean only 4 years back in 2010, hence, were at an early phase and had a long way to go towards complete transformation. Still a significant difference was found in the current status of lean initiatives among lean initiated and non-lean initiated apparel units. But still there is a long way towards full implementation of lean in the apparel units and ultimate goal of perfection.

Limitations of the Study and Scope for Further Research

For assessment, the number of units was limited to 10 lean initiated and non -lean initiated units each manufacturing ladies garments in NCR.

The following can be considered as scope for further research in this area :

(i) Lean initiatives in apparel units can be assessed after 5 years of its implementation.

(ii) A longitudinal study could be conducted to understand the long-term effects and benefits of lean in the Indian garment industry.

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