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Impact of Lean Manufacturing on Performance and Organisational Culture: A Case Study of an Apparel Manufacturer in Sri Lanka

Gamage J.R.¹, Vilasini P.P.G.N.², Perera H.S.C.³ and Wijenatha L.⁴

Abstract:

The rapid change in fashion designs, varying order quantities and increasing quality levels at lowest possible cost, demand the apparel manufacturer to be focused on more effective and efficient manufacturing processes for survival in an immensely competitive market. The necessity of reducing cost of production has left manufacturers with the challenge of adopting lean manufacturing where the focus is on waste minimisation. The purpose of this study was to investigate the applicability of lean manufacturing practices for the apparel industry in Sri Lanka. The main objectives were to implement lean practices in an apparel manufacturing factory, to assess its influence on manufacturing performance based on lean performance indicators and to qualitatively compare the impact on the organisational culture with that of the Toyota Production System (TPS).

A leading apparel manufacturing facility was identified which had already initiated the process of lean implementation. The initial state of performance and improvements after lean implementation were measured through key performance indicators (KPI), such as dock-to-dock, on-time delivery, first-time-through, fabric utilisation, etc., generated from published records and the company's resource planning system. The impact of lean manufacturing on the organisational culture over the period of lean implementation was analysed through interviews and direct observation of the personnel who were directly involved with the implementation process.

The KPIs reflect a favourable influence of lean adoption in bulk apparel production and a favourable cultural change towards one associated with TPS. The results showed that the lean implementation caused a reduction in the cost of production (10%), reduction of lead time (30%), and increase in plant efficiency (20%). Based on the positive trends of qualitative and quantitative performance indicators it was concluded that organisations in the bulk apparel production industry could achieve positive cultural shift and gain financial benefits as well through implementation of lean manufacturing practices.

Keywords: apparel industry, key performance indicator (KPI), lean manufacturing

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Introduction

The apparel industry is an important contributor to the Sri Lankan economy. It has become Sri Lanka's leading export industry since 1986 (Dheerasinghe 2009). It is also the country's prime net foreign exchange generator since 1992 (Kelegama and Foley 1999). The total value of export earnings in the sector was at US dollars 3,761 million, accounting for 53 per cent of the total export earnings in 2009 (Central Bank of Sri Lanka 2009). The contribution to the gross domestic product (GDP) was 15 percent in 2009 (Central Bank of Sri Lanka 2009). This industry provides more than 330,000 direct employment or 5 percent of country's total employment in more than 1,060 garment factories (Dheerasinghe 2009). These statistics clearly indicate that Sri Lanka is highly dependent on the industry for both employment and foreign exchange earnings.

However, the boom period of the industry is gradually coming to an end, with the quota system having ended in 2005, regional trading blocs and bilateral free trade agreements proliferating and governing nearly 33 percent of global trade, and China emerging as a major supplier of garments at very competitive rates (Kelegama 2005). Furthermore the increasing competition from low-cost manufacturers and the slow progress in domestic infrastructure development impairs external competitiveness (World Trade Organisation Secretariat 2004). Later in 2008, all the manufacturing industries were badly affected by the global recession (Sng, Ying et al. 2010) and the apparel industry was not an exemption. While recovering from this economic condition, the Sri Lankan apparel industry is facing the challenge of being competitive within the region.

In order to remain competitive, an industry needs to upgrade its technology, rationalise costs of production, improve product quality and speed of delivery, maintain high labour standards, and develop a domestic input base (World Trade Organisation Secretariat 2004). As a result most of the garment industries geared themselves to face these challenges by redefining, redesigning and improving their production systems. Within this context, they implemented different methodologies which were practiced by different manufacturing sectors in different countries.

Lean methodology is one of those concepts introduced to the apparel sector with the objective of increasing productivity, improving product quality and cycle time, reducing inventory, reducing lead times and eliminating manufacturing waste. All these objectives will ultimately formulate one core objective of providing an enhanced customer satisfaction while eliminating the waste activities of manufacturing. Lean manufacturing is yet to be spread widely in the Sri Lankan apparel industry. The theory of lean manufacturing needs to be adapted accordingly to suit the particular industry in concern. This is because it is difficult and misleading to use the lean experience (activities and performance indicators) in another industry as a reference point. The economic, cultural and social background of the Toyota Company, where lean manufacturing was developed and is practiced extensively, is largely different from that of companies in Sri Lanka. Therefore, this research focuses on how lean practices are introduced and practiced and how well the objectives are achieved in the selected case company.

Firstly the paper presents a review of literature on lean manufacturing with reference to fundamentals and approaches of lean implementation suggested by previous researchers. Then the methodology adopted by the case company and how it was implemented are discussed. Finally, the improvements gained by the case company with respect to the set KPIs and how the impact in company culture is discussed in the results section.

Literature review

Manufacturing industry has shown a significant growth through increasing productivity and product quality while reducing product lead times utilising variety of strategies which

are based on technology, employees, process, product, material and management (Kumar 2006). The improvements are achieved through process management strategies such as reduction of human efforts, space, engineering hours, lead times and inventory while increasing the quality, product variety and the flexibility of manufacturing operations (Diekmann et al., 2004). Different philosophies were also introduced to the manufacturing industry, namely total quality control (TQC), total quality management (TQM), theory of constraints (TOC), just-in-time (JIT), lean manufacturing, total productive maintenance (TPM) and six sigma. A critical review on these strategies by Stamm et al. (2009) concludes that aforementioned strategies have a common core aim of eliminating waste or variability using different approaches. Furthermore, Hines et al. (2004) mentioned that the other manufacturing strategies can easily be integrated into lean without contradicting the strategic objective of lean, to provide customer value.

A recent study on benefits of lean methodology by McGrath (2007) indicates that the main driver for becoming lean for most of the companies is to make profits either directly by reducing costs or indirectly by improving productivity. This may be the likely reason that many industries including apparel manufacturers opt to use the lean methodology in being competitive. Liker and Morgan (2006) state that even though many companies adopted some type of lean initiative, most of such efforts represent quick fixes to reduce lead time and costs and to increase quality which almost never created a true learning culture. Implementation of new manufacturing practices has not always been successful as the focus had been mostly on technical factors with little concern for soft issues like organisational culture which has been often ignored (Nahm et al., 2004). Furthermore, Forrester (1995) states that the change in culture to lean manufacturing is a profound one. Therefore studying both of these facets, namely technical performance and cultural impact, are critical in lean implementation.

What is Lean manufacturing?

At the early stages of its conception, the lean approach was used as a tool to improve the operational performance of an automotive manufacturer, but has now become a management approach for improving operational and socio-technical performance in all aspects of production (Joosten et al., 2009). Sanchez and Nagi (2001) define the lean concept as an operational practice which focuses on the productive use of resources. According to Liker and Wu (2006) explain that the lean philosophy in manufacturing aims at delivering the highest quality products at the lowest cost and time. Shah and Ward (2007) suggest that the lean concept is a combined socio-technical system which eliminates waste by reducing the effects of external variability in a supply chain and internal variability in a production process. However, Womack and Jones (1996) suggest that the central focus of the lean concept lies in continuous improvement in order to minimise waste and maximise value for customers. From the foregoing definitions, it could be concluded that the lean concept is a systematic process for eliminating waste and improving operational efficiency such that the production activities will continuously meet customer expectations at the lowest possible cost through the interaction of the worker with the process. Lean manufacturing involves a variety of principles and techniques to eliminate waste and non-value-added activities at each production or service process which results in improving customer satisfaction.

Methodology

A leading apparel manufacturing facility was identified which had already initiated the process of lean implementation. The literature on TPS and lean implementation on other industries was comprehensively studied and relevant performance indicators were

identified. The initial state of performance and improvements after lean implementation were measured through KPIs, such as dock-to-dock, on-time delivery, first-time-through, fabric utilisation, etc., generated from published records and the company's resource planning system.

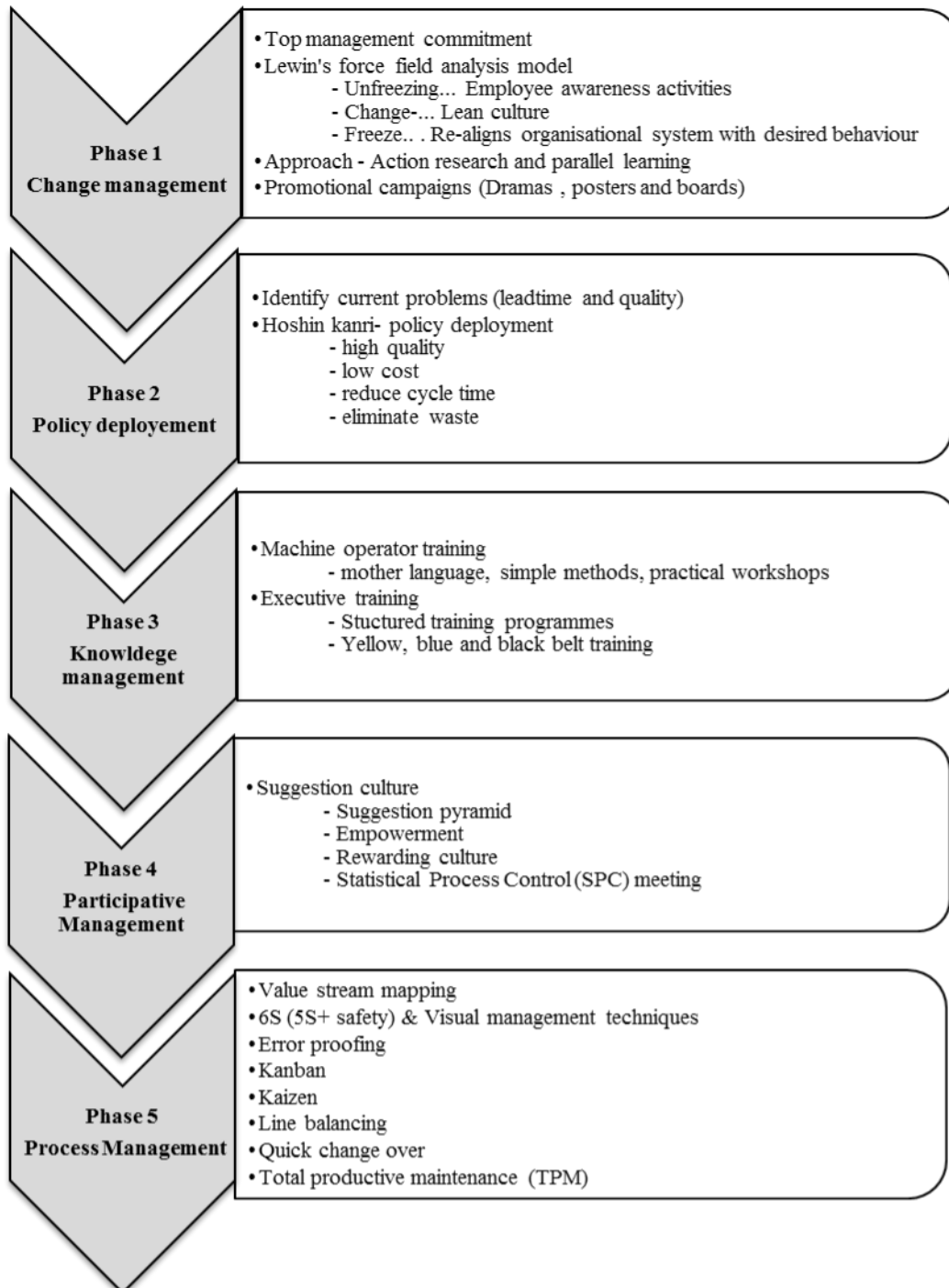


Figure 1. Lean Implementation Model Used By Case Company

A five phase model was developed, as illustrated in Figure 1, to implement lean manufacturing to suit the context of the Sri Lankan apparel manufacturing culture and the availability of resources. Then the step by step implementation was carried out using the model developed. The data to calculate KPIs were monitored and recorded throughout the period of implementation for analysis purposes. The impact of lean manufacturing on the organisational culture over the period of lean implementation was analysed through

various layers of workforce, via interviews and observation of the personnel who were directly involved with the implementation process.

Case Study Analysis

The company appointed a team comprised of internal staff and external experts on lean to carryout and monitor the implementation process. The model was used as a systematic approach in identifying and eliminating waste or non-value added-activities through continuous improvement by making products on time with best quality and lowest cost. To monitor and evaluate the effectiveness of the implementation process, different indicators were used mainly dock to dock (DTD), raw material on time delivery (RM-OTD), floor space savings, first time through (FTT), fabric utilisation ratio, plant efficiency and on-time shipment in full (OTSF). Definitions of these indicators are listed in the appendix. These KPIs were selected to provide a meaningful indication of performance in supporting the success of their lean journey. The way each phase was carried out during the implementation is discussed below.

Change Management

This was a main objective and a challenge where the lean implementation team (LIT) followed a well planned approach to attract and align employees to the lean culture based on Lewin's force field analysis model (Lewin, 1947). The LIT also used the action research approach as well as parallel learning approach for the positive transformation of the culture. The team was intervening and resolving the conflicts and issues encountered during the implementation phase. Employees at all levels were encouraged and facilitated to actively take part in the problem identification and applying relevant lean tools while customising them to the context of bulk apparel production. Top management commitment along with the LIT's strong belief of success was key for the positive culture shift. Dramas were used to communicate well and establish the lean concepts among all levels of employees. This approach helped to foster the idea of lean while eliminating possible resistance for the changing culture.

Policy Deployment

Objectives of the lean project aligned with the organisation's vision were defined as the first step with the guidance of the top management. This vision was well communicated and the commitment of all employees was focused towards achieving the desired future state. The goals were high quality, low cost, and fast delivery through shortening the production flow by eliminating waste. Traditional mass production primarily focuses on the cost reductions through individual efficiency gains within individual operations whereas lean manufacturing focuses on quality and doing each activity right at the first time which will simultaneously reduce cost and improve quality. Achieving lowest cost and shortest lead time are essential to compete in the global apparel market. These two aspects are lagging among all the Sri Lankan apparel manufacturers (Kelegama, 2005). Just-in-time (JIT) and built-in quality concepts were used in addressing those aspects.

Knowledge Management

Awareness programmes were conducted considering the employees' educational level. Training was conducted in the local language for sewing machine operators together with other teaching aids to convey the message correctly. Furthermore, workshops with practical demonstrations were used to improve the awareness on lean among employees of all levels. Knowledge was shared amongst the executive level and upper levels through structured training programmes called Belt trainings. There were three levels of belt

training namely yellow, blue and black. At the end of each training session, examinations were conducted to assess the knowledge gained.

Participative Management

This strategy aimed at involving employees from multiple functions and levels to work together to address a problem or improve a particular process. Employees were welcomed to make suggestions to improve the current processes. These kaizen activities played a vital role in participative management. Suggestion pyramid was another method used to obtain the feedback of the employees and sharing it with others. This was a pyramid structure displayed in the production floor visible to all encouraging others to generate their own new ideas thinking along the already posted suggestions. Innovation of needle finder and button attaching using Bar Tack machine were two key examples of this effort. Employees were rewarded based on the financial benefits to the organisation on the implemented suggestions. Apart from that, Statistical Process Control (SPC) meetings were conducted by production line supervisors along with machine operators to find solutions to their work related issues when practicing lean manufacturing.

Process Management

The case company used formal lean manufacturing tools and techniques to reap the benefits by effectively amalgamating human resources with manufacturing process. These include value stream mapping (VSM), 6S (5S and Safety), visual management techniques (VMT), error proofing, kaizen, total productive maintenance (TPM), standardisation, quick changeover (QCO), line balancing and kanban. In VSM, a work plan was prepared to achieve the future state map. A work plan to address the opportunities revealed from brainstorming sessions was developed which consists of measurable goals based on clearly defined lean metrics. Furthermore, the initial 5S programme was extended to the 6Ss introducing safety as the 6th S where the 6S programme ultimately provides a strong foundation for higher quality and productivity, cost reduction, timely delivery, greater safety, and higher employee morale. VMT facilitated in identifying real time process information such as signalling of malfunctioned equipment and in conveying information such as production line performance.

Standard operating procedures (SOPs) were developed for individual manufacturing processes such as cutting, raw material sorting, quality inspection and laboratory tests using standard work sheets. Physical space and the documentation practices were standardised through the 6S programme. The quick change-over (QCO) technique was used to shorten the work cell set up times and a pre-preparation area was allocated allowing mechanics to perform machine setting-up operations before style changes. After a series of kaizen events on set-up time reduction, the changeover times were reduced from 3 days to an average of 15 minutes.

The kanban system was implemented throughout the bulk production value stream from material stores to the packing section with two types of card systems, namely production kanban and withdrawal kanban. PDCA cycle (Plan-Do-Check-Act / Deming cycle) meetings were conducted at each production line to generate and implement kaizen ideas while promoting a participative culture. These kaizen projects were targeted on efficiency improvements, cost saving projects by reducing overheads, sewing technique standardisation and suppliers development to minimise the quality inspection of all supplies thereby reducing non value adding activities. It was interesting to note that the kaizen implementations coupled with the reward system significantly improved the employee motivation towards the new kaizen culture. The use of the aforementioned tools

provided a direct impact to the company's set objectives and KPI's during the lean implementation.

Results and Discussion

The lean practices discussed in the above sections are in different levels of implementation in the case company as it is a never ending journey. In identifying the impact of lean practices in any organisation, it is essential to have industry specific indicators. But the published literature lacks such lean indicators specific to the apparel sector. Hence, the analysis of results is based on the specific quantitative performance indicators used by the subject. It is interesting to note that almost all the KPIs used by the subject have shown favourable trends during the lean implementation process. Authors have used most of the important KPIs that are being generally used in the apparel sector to discuss the results whilst some are exempted due to the sensitivity to business performance of the subject. The following sections discuss the impact on performance and the culture of the organisation considering the KPI variations over a period of two and half years of implementation (Please refer to appendix for definition of KPIs).

Dock To Dock (DTD)

DTD is a measure of the product flow speed through the factory in days. This is a KPI that clearly indicates the inventory of the company which is one type of waste category identified under the seven wastes of lean manufacturing. The indicator was calculated for three inventory forms namely raw material, work in progress and finish goods. (Please refer to appendix for definition of KPIs). It is interesting to observe that all three graphs in Figure 2(a), (b), and (c) reflect a gradual reduction in time taken in DTD transfer over a period of two and half years. This improvement of speed was regarded as a benefit of lean implementation over the same period while reducing the inventory level. Concepts including backward integration, proper inventory management with visual management techniques, line balancing, quick changeover and TPM were main reasons for these positive trends in DTD indicators.

Raw Material On Time Delivery (OTD)

Supplier integration to lean philosophy is critical to reap the full benefits of lean manufacturing. Raw material OTD indicates how well this integration has taken place. This relates to the transportation and waiting losses discussed in the seven wastes of lean manufacturing. Raw material OTD percentage has continued to improve (refer Figure 2(d)) over the period of study despite the major downturn for few months from late 2007. Most of the raw material suppliers are still in the process of aligning with lean principles which could be the reason for the below 60% OTD value during the period. It is expected to grow in the future with more attention put towards the backward integration process of the subject.

First Time Through (FTT)

This is a direct indicator of the lean waste of quality defects which requires reprocessing of garments. It is interesting to see that the FTT has improved from 60% to 94% during the lean period (refer Figure 2(e)) of lean implementation which was a drastic performance improvement of the company. Lean tools like SPC, PDCA, error proofing and line balancing were used to achieve this enhanced performance. Those tools and lean conducive environment helped employees to find problems first hand and rectify them then and there. Measures were taken to prevent such issues being occurred again.

Plant Efficiency

Figure 2(f) shows an overall plant efficiency improvement of 20% (from 45% to 65%) during the period of lean implementation which is considered a benefit of being lean. This could be explained as a collective influence of all lean practices undertaken though QCO, PDCA, SPC, line balancing and TPM. Maintaining the positive trend started would allow the company to further expand its horizons while facing the immense competition in the apparel sector.

Fabric Utilisation Ratio

Waste minimisation and quality improvement activities have mainly driven the improvement of the fabric utilisation ratio. As the fabric cost is the largest contributor to the cost of a garment, increase in this ratio has a direct impact on improving profitability. The lean implementation has enabled the company to achieve above 99% in the fabric utilisation ratio (refer Figure 2(g)) which is a gigantic saving to the company. TPM, QCO, VSM and Kaizen activities helped to minimise the number of defected garments which contributed to this exceptional performance.

Delivered On Time and Delivered In Full

These indicators reflect the benefits of lean to the downstream participants of the supply chain. It measures how often customers get the required quantity at the required time. Both KPIs reflect high performance (above 99.5%) of the case company with a favourable trend as well (refer Figure 2(h) and (i)). The value stream mapping tool was used to identify the non-value adding activities in the production process and using the other lean tools the value addition was gradually improved ultimately resulting in superior performance. The efforts on lean helped to achieve improved customer satisfaction while the above KPIs could be used to win new orders catering wider customer base.

Floor Space Savings

The company was able to save over 20,000 square feet of total floor space during the period of lean implementation. This was mainly achieved through 6S activities and kaizen activities which contributed largely. Furthermore, practicing the demand pull production facilitated to reduce WIP freeing more space for value adding activities. This eventually leads to reduce the wasted motion of both workers and material allowing them to use the recovered space for alternative value adding activities.

Elimination of non-value adding activities and strict cost reduction practices helped to achieve a drastic cost reduction of 10% for the group during the last year of study. Implementation of lean in the case company together with other companies of the group has resulted a 30% overall reduction of lead time. It is evident that the case company has achieved drastic performance improvements with the lean implementation.

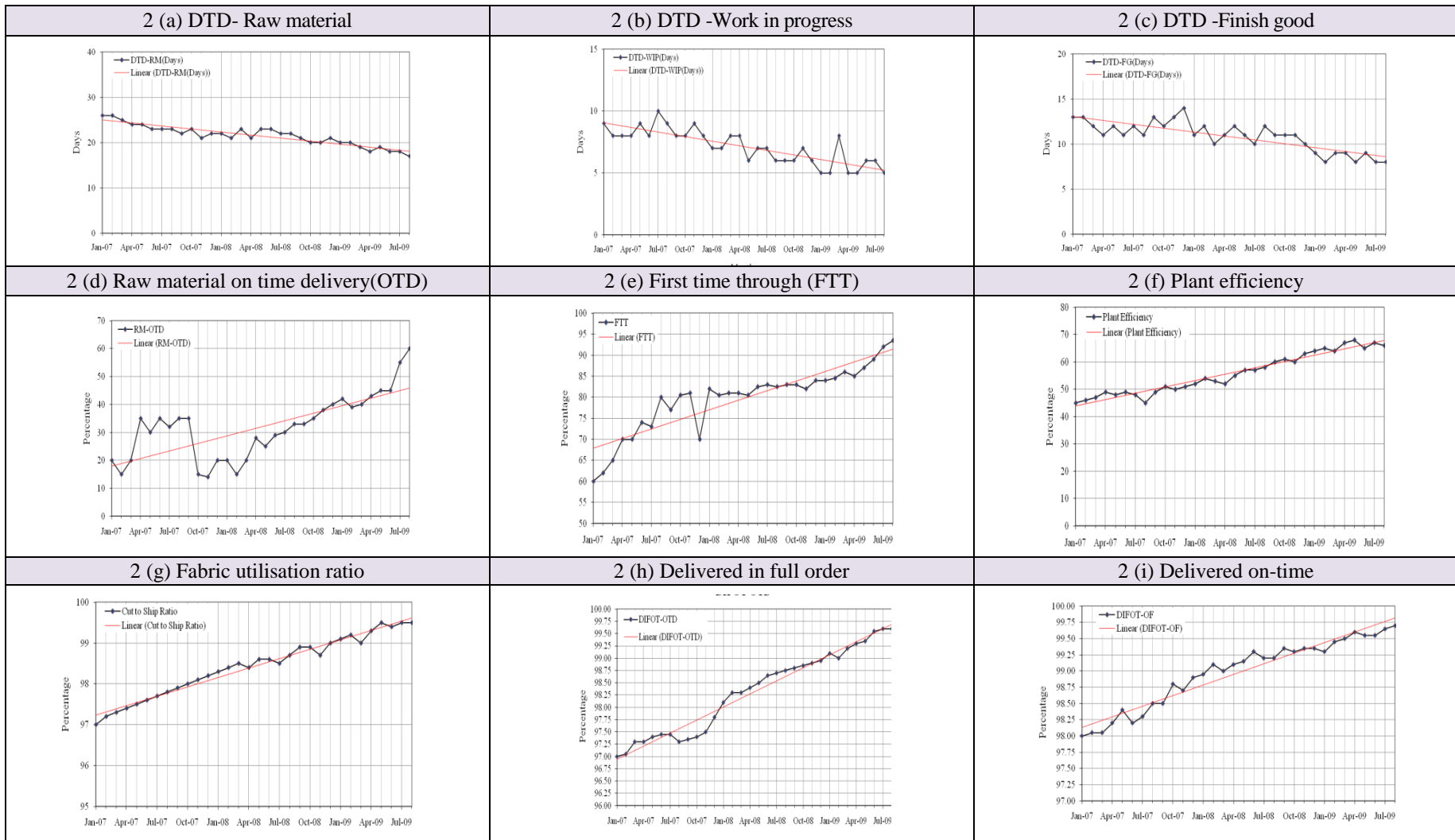


Figure 2. Improvements of KPIs During Lean Implementation

Impact on Organisational Culture

This was a main objective and a challenge for the LIT as introducing a foreign manufacturing practice to a completely different culture expecting same benefits is a tough task. As resistance is inevitable the LIT undertook a progressive approach as discussed in the methodology section. There are number of cultural elements in Toyota that are adopted by the case company successful whereas some elements are difficult to practice due to the cultural differences.

Employee Culture of the Case Company

Sri Lanka is reputed for a culture of respecting elders, seniors and educated where the same can be seen within the workplace as well. Being a developing country suffered from 30 years of civil war inhibited the economic growth making companies to struggle in surviving in the global competition. This socio-economic environment made an employee culture of following the instructions received from superiors rarely questioning or suggesting any improvements. The operator level employees were not supposed or encouraged to take part in decision making process of the day to day operations or development projects. Furthermore, majority of operating core workers are females in the apparel sector in Sri Lanka where mostly a male dominant culture is evident. This further causes a step-back culture within the corporate environment. Having this type of cultural background LIT initiated implementing the lean culture in the case company.

Comparison with Toyota Culture

The Toyota culture views problems as opportunities to improve (Liker, 2004). This leads to early diagnosis of the problems and facilitates to resolve them effectively. It requires the employees' quick initiative to communicate the problems to their superiors and generate solutions collectively. Even with a culture with reluctance to voice such issues to superiors the case company managed to successfully implement it with the progressive change management process discussed in the methodology section. Similarly most of the elements of the Toyota culture including team working, quality consciousness, appreciation with rewards, and equality of treatment have successfully practiced in the case company with lean implementation.

However, some aspects of Toyota culture are still difficult to implement due to cultural differences. For example fostering contradictory view point concept to generate new innovative ideas is rarely used by the case company. This is mainly due to the employee reluctance to argue with their superiors in conflicting ideas. Another such practice is use of constructive criticism by employees of all levels to provide a valuable feedback among all levels. Even though this is easy to practice top to bottom due to the culture of respecting superiors it is hard to fully practice.

Table 1 qualitatively compares and summarises the key elements of TPS, including culture, with that of the case company.

Table 1. Comparison of key elements of TPS including culture with the case company

Factor	Toyota (Liker, 2004)	Case Company
Problem Solving Culture	Problems deemed as ‘opportunities to improve’ Seek root cause by asking what, why, not who.	Problem is defined as discrepancy between the current situation and the standard. Different tools like PDCA and SPC meeting , 5 why, cause and effect and cession trees used
Team working culture	Team members viewed as a fixed cost “asset” Much effort placed on recognition, little focus on blame.	Culture embraces trust, encourages openness and fosters teamwork Teams are strengthened with team building exercises
Quality Concern	Customer driven, Create long-term success by creating environment where team members have the same beliefs and values as company.	Focus on product quality and process quality
Equality of treatment	Effort made to eliminate distraction in the workplace. Shown by use of “uniforms,” common parking/cafeteria, few offices.	Friendly working environment indicated by common cafeteria, addressing employees by name and the use of constructive criticism
Management style	Direct involvement, visit shop floor often. Expected to see problems firsthand.	Style with strong backing from top management
Worker - Management relations	Co-destiny cooperation	Empowerment
Reward system	Focus on teamwork and on process as much as results. “Team” environment.	Ideas are implemented and rewarded based on the cost benefits
Standardisation	Leave effort placed on standardising as much as possible. Little variation in values; fundamentals from location to location.	Aims to maximise performance while minimising waste in each individual operation and workload through standardised processes
Communication	Open structure with few barriers (“bullpen” atmosphere). Information “sharing” environment with a consensus culture.	Information is available to everybody in the organisation and developed links between employees
Training and development	“On-the-job” focus with direct tie-in to work environment. Teaching is done by supervisors most of the time.	Trainings which related to day-to-day work as well as trainings on soft skills were given to the employees by experts in the company or qualified resource persons.

Challenges faced during implementation

The main challenge was to align the workforce towards the lean culture. It has to avoid the employee resistant to change while implementing new or improved working practices and educating them who were in different levels of knowledge and skills. However these challenges were dealt successfully as described in the change management section.

Other difficulties faced include fully standardising majority of production processes with rapidly changing product designs, lack of infrastructure to effectively initiate lean suggestions, doing infrastructure changes with budget limitations and lack of local experience and expertise in lean implementation. All difficulties were prevailed by proper planning with the confidence of top management.

The above discussion shows that the case company have benefited a lot from successfully adopting and practicing the lean culture. It is evident a strong positive cultural shift in the case company after the lean implementation when compared with early situation.

Conclusion

The implementation effort of lean manufacturing in a bulk apparel manufacturer in Sri Lanka was extensively studied to understand the impact on the performance and organisational culture. A number of industry specific KPIs were used (refer appendix) to evaluate the performance over the period and qualitative analysis was carried out to find the impact on the organisational culture. During the process of lean implementation the subject was able to introduce and sustain number of lean practices which are still being practiced. A well planned approach was taken to smoothly tailor the culture towards a lean one using numerous employee interacting activities. This new culture has initiated a multiplier effect on improving the performance and maintaining the introduced lean practices on a regular basis. It is acknowledged that the cultural influence plays a vital role in improving all the other performance measures.

It is evident that the case company has achieved remarkable success performance in a short period of time with the chosen lean tools where other companies in the sector could use this as a benchmark. Hence, the prevailing situation encourages the organisation to further proceed on the lean journey to expand its horizons of competitiveness. It was understood that lean manufacturing is not a widely practiced tool yet in the Sri Lankan apparel industry though the topic is being widely discussed. Authors believe that it is due to the difficulty of adapting into the lean culture where a well organised approach is essential. Further, it is hard to use the experiences of other industries in foreign countries as a basis due to the differences in working culture and nature of the operation itself. However, it is proven that efforts taken in implementing lean manufacturing in a well planned manner will be a worthwhile investment despite the difficulties faced. Based on the positive trends of qualitative and quantitative performance indicators, it can be concluded that organisations in the bulk apparel production industry could achieve a positive cultural shift and gain financial benefits through the implementation of lean manufacturing practices.

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Appendix: Equations Used to Calculate KPIs

Dock To Dock_ Raw Material;

$$\text{Dock to Dock_Raw Material (DTD_RM)} = \frac{\text{RM stock value at the end of the month}}{\text{Average RM consumption per day}}$$

Dock To Dock_ Work In Progress;

$$\text{Dock to Dock_Work in Progress (DTD_WIP)} = \frac{\text{WIP stock value for the current month}}{\text{Average RM consumption per day}}$$

Dock To Dock_ Finish Goods;

$$\text{Dock to Dock_Finish Goods (DTD_FG)} = \frac{\text{FG stock value at the end of the month}}{\text{Average cost of sales per day}}$$

Raw Material On Time Delivery;

$$\text{OTD_RM(\%)} = \frac{\text{No. of deliveries completed on time}}{\text{Total no. of deliveries planned for the month}} \times 100$$

First Time Through;

$$\text{FTT(\%)} = \frac{\text{Number of quality units produced}}{\text{Total number of units produced}} \times 100$$

Fabric Utilisation Ratio;

$$\text{Fabric utilisation ratio(\%)} = \frac{\text{Shipped quantity}}{\text{Quantity of fabric cut}} \times 100$$

On Time Delivery_Finish Goods;

$$\text{On time delivery (OTD) Finish goods} = \frac{\text{No. of deliveries completed on time}}{\text{Total no. of deliveries planned for the month}} \times 100$$

Delivered in Full or Order Fulfilment;

$$\text{Delivered In Full (DIF\%)} = \frac{\text{No. of garments delivered per month}}{\text{Total no. of garments planned to deliver per month}} \times 100$$