

Comparative Analysis of Lean Sigma Application in Manufacturing Sector in India

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Abstract—The lean methodology has penetrated into the Indian mainstream services and manufacturing much late when compared to the ISO and QMS. The ideal quality tool, which is used for optimisation of existing workflow production process is perhaps the biggest game changer to usher innovation in the industrial history. Many Indian firms typically has traversed the quality journey with ISO, QMS certification which is more client centric compliance while TPS is still yet to be explored. The success of Lean depends on the tools, team and tenacity which in Indian scenario explains the way adoption process is being perceived by large scale, SMEs. Some of the tools used in Lean are TQM, JIT, SixSigma, Kanban, Agile methods, Job reengineering, Benchmarking, SPC, TPM which has found its way to strengthen the position of the Indian conglomerates. This paper therefore will try to map out the immense benefits which the Lean based QC tools have aided innovation in the manufacturing sector in India. Lean management strategies are now statistically measured and tracked using the Lean Six Sigma methodology for the adherence of quality metrics. The changing trends of quality tools usage and its adoption barriers, in respective domains of Indian industry will be explored that has helped to eliminate non value added elements. So reduced time spent on non-productive and non-value added work has opened up more scope to innovate and streamline the existing production process. We will take a look as to how these lean tools mentioned above has found its way to different Indian industries and functions have been a part of their journey in recent years. This study is pertinent when the nation is waking up to 'make in India' strategy which soon will seek actionable results in future. Indian firms to be world class manufacturer thus needs to pursue 'lean management systems' methodology earnestly to innovate to show its capability with developed nations.

1. INTRODUCTION

The Indian manufacturing has evolved and matured over the last century in terms of technology, productivity and efficiency. It is growing faster to challenge the globalised competitive market constantly by deploying advanced level quality tools [15]. The export oriented Indian manufacturers initially had to comply and get certified to appease the foreign counterparts showed that the quality movement was more of a client induced effort. So the quality efforts found in larger Indian enterprises was through certification that is still prevalent practice in Indian manufacturing industry saw a change in the last two decades. The shift in application of quality practices in other domains like services: IT, Telecom

have emerged which proves that it is a continuous process. So TPM (Total Productive maintenance), TQM (Total Quality Management) and the quality philosophy as an ideology of the Japanese gurus found Indian work culture difficult initially to assimilate and master, has now moved to deploying higher level quality tools. This is evident as certifying ISO9000 or ISO 14000 has not led to winning Malcolm Baldrige Award or Deming Award which few of Indian enterprises have been able to boast [2]. Application of Six Sigma, BPR (Business process re-engineering), VSM (value stream mapping), AM (Agile manufacturing), LMS (Lean Management systems) have found place in the Indian quality toolbox across domain [3]. Much of it is driven by competition and the innovation in products and service for the business profitability. These are predominantly used to control the variation in the production, and also to be responsive to the market demands. So the companies with wider portfolio of products like FMCG (fast moving consumer goods) are seen to adopt FMS (flexible manufacturing systems) that seemed to echo the AM (Agile manufacturing) [4]. This is pertinent as innovation in manufacturing will increase the country capability in engineering prowess that will act against the much needed, 'transfer of technology' which India is dependent upon. Deploying lean management systems in every sector and functions in management will help to tide over and bring in self sustainability of our actions in years to come.

The structure of this conference paper spans out in section two which is literature review, followed by methodology adopted in conducting the research at the third section. The fourth is the findings and the fifth discusses the discussions of the previous section with recommendations.

2. LITERATURE REVIEW

2.1 Background history

An offshoot of TPS (Toyota Production System), Lean management was developed by Taiichi Ohno, emerged over the decades in an understated way. It supports the process approach in its core, and helps to product or service to flow seamlessly through the production process by value adding

without any interruption [5]. The customer centric 'pull' of demand of the product or service thus is created without defects, with optimised six sigma quality, eliminating every possible type of wastes [4][6]. Some of the elements which Lean management uses that are not directly defined by TQM, are as follows:

- **Value:** The concept of adding value that benefits the customer in terms of right kind of product as demanded, at right place and time.
- **Value stream:** are combined set of activities from order to delivery(end to end process)
- **Flow:** the smooth flow of product in a production environment through a series of value adding activities.
- **Pull:** the customer initiated actions which contains the needs, wants and desires
- **Perfection:** The value added in the production also eliminates the defects in the process.

Essentially when compared with other quality tools, Lean management is holistic, more of combined management oriented approach, possessing dynamic orientation towards improving quality [3]. However, in Indian context the success of Lean management journey in attaining perfection has been tougher when compared to TQM. Larger organisations have been able to understand and adopt lean practices show that it is a growing competence which Indian SMEs struggling to adopt [7].

In this paper, an attempt will be made as to how the LMS (lean manufacturing system) is being increasingly used by Indian industries both manufacturing and service sector. It will try to understand if Lean management replaced the TQM, TPM, ISO or if it is an output of CI (Continuous improvement).

2.2 Lean Management

Lean is defined as the production process (manufacturing, services) which uses optimised space, inventory, lesser defects,

2.3 Lean Management Methods

- 5S
- TPM
- Kaizen
- JIT
- Kanban (push-pull)
- 3P (pre-production planning)
- Cellular Manufacturing
- Six Sigma (DMAIC: Define, measure, analyse, improve, control)

2.4 Lean Management system

It consists of holistic approach to resolve problems of an organisation that consists of series of techniques:

2.5 Principles in Lean Management system

- Identify value
- Map the value stream
- Create the flow
- Establish pull effect
- Define perfection

This was proposed in lean thinking, which is applicable to any industry [9]. The quality principles as mentioned in the house of quality also has evolved with the focus on the customer or stakeholder focus. In Six Sigma quality it was about meeting customer needs constantly and perfectly. The management per se, needed much more than structural framework or statistical calculations of SPC. LMS involves the SIPOC (supplier, input, process, output, customers) and also the COPIS which understands the value add to every activity. In many Indian firms, implementation barriers were seen as each of them had internal difficulties of infrastructure, employees, finance and defining it. LMS caught on post 2000 globally, though JIT(just in time) and TQM was still prevalent at employee level activity [9]. Some of the major projects in DRDO is now currently deploying lean techniques to commercialise the space launch missions. So the success of the LMS is found at its best, when it happens end to end implementation [10]. Firms have been seen to engage into multiple quality tools, encourage employee to adopt an attitude to eliminate waste as a companywide philosophy, multi-staged quality control as a culture with everyone contributing to make LMS work[7][21][18]. So with each of the production process being different, adapting the LMS with process mapping approach to WBS (work breakdown structures) is predominantly seen. This is helping firms to understand the role, responsibilities of each employees as a 'process owner' [11]. The next issue is the adoption and performance, that has seen which seeks to understand the positive and negative outcomes against the successful expectation.

2.6 Mudras in Lean Management system

Despite the many advantages, the LMS is more arduous though it has quality principles found in every stages. The incremental reduction and which is continuous improvement is essential to its theme [12]. The wastes of 'Muda' here requires introduction. In Japanese, it is futile efforts in terms of usefulness, idleness, waste, wastage (act), superfluity that is at the core of TPS. Seven wastes are typically found: motion, waiting, over processing, over production, defects, inventory and transportation [13]. So all of these when not present equals to the value added activity to the production as per LMS.

Any employee with specialised skills at the wrong role or position is also the 'eighth Muda' as per Lean ideology.

2.7 Agile application in Lean Management system

The issue of frequency of production or the how much faster or slower explained in terms of agility requires some discussion as it is related to over and under production. The market led demand is a function of the consumers who are acting on their terms which creates a pull in the total production process. So with varied product portfolio when the demand for a particular SKU is high, manufacturers try out a flexible approach to resolve the predictive and adaptive dilemma. Typically used in IT (information technology, it consists of series of interconnected activities that are responding quickly to demands and changing production lines along with continuous improvement [14]. This is possible only when the total task is broken down into smaller activities using WBS that are time based. The agenda is similar to smaller batch processing in lots using FMS (flexible manufacturing systems) by manufacturing firms. Here, the quality is tested through continuous integration, in software testing, test development, design, patterns, code refactoring [15]. The discussion points at the philosophy of how industries are adapting LMS in actionable frameworks to achieve project speed and control it, and yet be accurate in the end result. So LMS is evolutionary as much of the agile is a based on CI, overcoming failures through efforts. Though there are different Agile manufacturing process borrowing heavily from quality, operations, LMS, management which drives the SDLC elements.

2.8 LMS approaches in Indian manufacturing sector

Production process in Manufacturing

The emerging Indian economy took bold steps in implementing ISO, QMS in the 80s and 90s. This was a part of the Indian economy liberalisation campaign which began in 1991. Many ancillary new support industries (suppliers, vendors) grew in order to support large scale Indian OEMs and MNCs firms [4]. So this significant shift in the movement that had taken place needed processes, systems to match between the OEMs and the smaller support companies. Classified as Tier 1 and Tier 2 companies these firms manufactured components that went into assemblies or sub-assemblies. Empirical study shows that Tier 1, Tier 2 in order to comply with OEM firm requirements had to align production process as per contract quality signed [17].

Freight and logistics management

Quality initiatives was also felt in the supply chain management which is closely linked to the warehousing, inventory management. The concept of Tier 1, Tier 2 and even in some cases Tier 3 suppliers evolved during this time showed the trend of new entrants in the market wanted to align their extended global supply chain to comply with OEM driven established pull in the supply chain [14]. So the plant

stock level, multi-phase QC checking, TAT (turnaround time) which is linked to PP (production planning) evolved as a prevalent practice [10]. The issue of reworks and streamlining production as per OEM specifications was felt in suppliers end in order to meet the global supply chain 'pull', which was supporting the unrestricted movement of finished product till it reached respective markets [18]. The whole process starting from design using DMAV methodology that emerged in designing new prototype in OEM, with fewer redesign, reworks affected all the suppliers in India [7]. IT in integrating, warehouses helped to bring in visibility at national and global level supply chain has been a critical to reduce the TAT. The phased approach of inventory reduction at each hub was done as quality movement was predominant in OEMs, to Tier1, and to Tier 2 [4]. This was clearly an indication of innovation in finding new opportunities in matching the MNCs performance wise.

Pharmaceutical sector

In pharmaceutical sector, Indian drug manufacturers have matched up the global pharma MNCs in terms of R&D and drug formulation show that pace of growth has kept up with the quality initiatives. In private firms, the most predominant requirements was to improve the service levels, enhance customer value, reduce cost and lead time in new drug R&D-testing, reduce working capital and to improve work culture. All these are part of the low cost generics that are being churned out of a host of Indian pharmaceutical firms and the rush intensified when the competitiveness factor pitched in [11]. So supplying to the global pharma majors, the priorities for the Indian drug manufacturers was improving service levels, adhere to GMP and meet the customer value that led to starting up 'operational excellence' in most of the firms [19]. Most of the lean philosophy, tools and quality improvements at R&D, testing and production phase was the standardised to meet the contract specifications. Lean was implemented by 50% of MNC pharma firms, ten years back and 57% Indian origin pharma majors that led to drastic improvement in terms of gaining cost efficiencies and improvement quality.

3. METHODOLOGY

The survey for the 15 Indian manufacturing companies (large scale) that surveyed over a year. Each of the industries 7 manufacturing, 5 pharmaceutical and 3 freight and logistics chosen where quality initiatives have been started. The questions were for the senior management who had thorough understanding of what, how, when of operational aspects and that also indicated authenticity of information. This method is apt as each firm is a unique case study as their lean approach to adopt quality is different, so semi structured interviews apart from the standard survey questionnaire was distributed to those who were part of quality management system. The LMS has been adopted already, while some firms was in the process half way achievement which made this approach pertinent.

4. FINDINGS IN THE MANUFACTURING SECTOR

In manufacturing, the prevalence of QMS, TQM, TPM, JIT, lean was seen as quality initiatives. This was prevalent in Indian OEM automobile industries, heavy engineering that spanned across PSU (public service union) and private entities. The Joint ventures with MNCs in automobiles ushered the quality revolution, with notable example of MUL formed with Govt. of India and Suzuki motors of Japan which introduced PMP and localisation of content down to 70% within 5 years of entry in Indian market (D'Costa, 1995). At firm level, the suppliers to OEMS were seeking to bag contracts needed to show standardised quality which brought in a flurry of quality initiatives in Indian enterprises. The OEM firm outsourcing the contract is at a risk of non-conformance as a 'Cost of quality' issue where time and commitment to volume ordered if missed would jeopardise the OEM production, assembly schedules and inventory [13]. However, the aim of the firms was to integrate the production process with suppliers and achieve using ERP, zero wastage and zero inventory at plant level [15][22].

In supply chain and logistics firms, which have ushered up in recent years, the inventory control is an issue. In this arena, the result which was noticed is that considerable experimentation happened due to variation in models and their demand in the market. This has affected the WIP (work in progress) where the firms aimed in achieving smaller lot in batch production in lesser time that affected sorties, route optimisation [7][20]. These companies were trying to maintain buffer inventories of each SKU to maintain the 'demand' pull from different customers across global markets. This approach quick shuffling and loading of SKUs while agile manufacturing was producing increased number of SKUs. Lean methods deployed to reduce defects, waste was introduced later. DC 'distribution centre' in supply chain hubs came up to save time and accuracy to ship right SKU to each customer [14]. This sector relied heavily in ERP that was found that the typical trend was to start along with quality is ISO certification, then TQM to implement QMS, and move into much more specialised TPS [18][22]. They improved space utilisation, tare utilisation by 49% when compared to what they had 5 years ago. Much of it was found to be dependent on strategic location of the hub but it affected with the core elements in inventory and warehouse management. In the long run, it was able to integrate to the required criteria on real time basis and achieve the time reduction agenda incrementally YoY (year on year). This also led to smoother flow customer driven 'pull' at 91% of times in logistics and freights and innovation like 'reverse logistics' is saving 35% energy(fuel spends) as a LMS initiative.

The quality shift in Indian pharmaceutical companies and movement in choosing the tools which was noticed in this sector was LMS 17% of Indian pharma, strategic cost reduction techniques 13%, Six sigma at 9%, BPR at 13%, TQM at 15%, TPM at 9% and rest ERP that is the critical part

in global drug development, in meeting GMP and supply system. Most of the Indian pharma majors reported that they have been able to meet the SLA (service level agreement) with 100% improvement in providing service level, improved response time 86%, reduced lead time 65%, improved flexibility 62% [20], increased profit 54%, reduced cost 46%, decreased inventory 45%, improved quality 46%, improve productivity at 39%. It helped to reduce bottle neck 30%, rise in throughput 25%, CEE at 29%, productivity 20%, yield 3.5% in pharma manufacturing. It led to reduction in RM stock outs 40%, FG stock-out by 30%, reduction in WIP by 35% and in lead-time by 36%. The above figures were achievable through the use of three major initiatives, Lean, Strategic cost reduction, ERP and six sigma which helped to adhere to GMP guidelines [22]. LMS was applied to R&D, planning, manufacturing, buying & selling to improve its value chain which involved top and senior management, middle management the most while workers and customers complied to set goals [24].

5. DISCUSSIONS

In the Indian manufacturing sector, the quality revolution though has been able to standardise the process, it is not able to balance or leverage the power of lean to the fullest extent as it is evident across sectors. Drastic improvements through lean only happened after fine tuning their attempts, out of which many of lean initiatives in respective departments either stuck or successful ones waiting to take off. Prioritising the levers that moves the KRAs of LMS requires experience and sticking to the elemental paradigms [24]. Most of the larger OEM firms showed LMS initiatives through diverse team, which later on percolated to the suppliers and vendors that showed the integration of supply chain management through continuous improvement. Cross functionality in teams, project based approach, change management team to assist pre and post stages, and tactical dashboard maintenance was found to be a leadership domain.

The next challenge for Indian firms which has found that LMS is much more focussed on externality as its success involves the broader stakeholders in end to end production and supply chain altogether. So LMS, it is next to Six Sigma and TQM tool, which allows stakeholders to comply for attaining the success jointly. Other activities like TPM, BPR, ISO, 5S, Kaizen, Kanban are more inclusive of the firm's operations. This can be leveraged with strategic cost reduction agenda by Indian firms while the only common platform being ERP.

It is evident that out of all the Indian firms in survey, very few have been able to see higher profits, smoother pull in lesser time, zero inventory as the visible results while some have been able to test at department level. Thus the LMS agenda needs management involvement with the stakeholders (end to end) across functions to reap the benefits of the organisation. The fastest to achieve LMS was seen in Indian pharmaceutical industry followed by freight and logistics as they started LMS

programme later than others. They have been able to achieve it within a span of seven months to just a year for some of the drug formulation cases slated to be released in International market. It speaks of the speed, accuracy and methodical approach that diverse teams in Indian Pharma majors deployed.

The predominant tools that they used is to adopt an excellence initiative from within at all employee levels. This shows that LMS tools, methods in application is more rational and that next level framework to bring quality into a holistic platform can be achievable as per the goals set by the firm in timescales. The manufacturing LMS programme was slower to take off when compared to the Pharma. In drug development most of the actionable agendas chosen was in accordance with client specifications. Similar internal issues in fuel spends was seen to erode freight and logistics firm profits that led to adoption of LMS. So some factors were external induced while others were due to internal ones.

The clogs of wheel in the LMS blockage are much harder to detect as the vastness of total layout of the total programme, hence, incremental efforts at employee, department, functionality, SBU and national level will enable its success. The visible proof for CAGR growth of Indian pharmaceutical majors, automobile exports, heavy machineries with full order book, freight firms expanding to ports in India are part of innovation and inching ahead towards the sustainability goals. "Make in India" can be modestly successful if engineering capabilities combined with our Govt. efforts to encourage SQC departments needs to have a stronger level of relationship to embrace LMS framework.

6. RECOMMENDATIONS

The key recommendations for the Indian industries which wants to embark upon the journey of LMS is to first define their goals for the year ahead and breaking it down into actionable SMART goals. Some of the measures which they can include in their LMS implementation programme is to understand their existing equipment capability and effectiveness with respect to the goals. They need to propose annual productivity plan, mapping on a dashboard based on historical data. Benchmark the industry leader, set the base year with scores for production, lead time, finished SKUs inventory, direct labour cost, measures labour value and time spent, defects in all forms and types, number of suppliers and segregated spends.

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