Developing a Roadmap to Become a World Class Manufacturing Company: A Case of Process Industry in India

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Abstract

The purpose of this study is to develop a framework for implementation of World-Class Manufacturing (WCM) in process industry which can guide and support for those process industries, aiming to start their journey to reach world-class standards in quality. World Class Manufacturing (WCM) includes various concepts, principles, policies and techniques for the management and operation of companies engaged in production in order to achieve competitive edge over competitors. The case study presented in this paper is from one of the India's largest crop protection chemical company which has set a target of bagging Deming Prize in next 5 years through TQM. The organizations applying for Deming Prize should achieve a business success through quality improvements. The various tools of TQM such as policy management, daily work management, autonomous maintenance, and lean manufacturing are discussed. In order to implement WCM in a process industry, this study gives a broader overview of WCM through TQM. With the context of WCM implementation in a process industry, the study is considered to be valuable and useful to the practitioners.

Keywords

World-Class Manufacturing (WCM), daily work management (DWM), autonomous maintenance (AM), policy management (PM), improvement management (IM), lean manufacturing (LM).

1. Introduction

The term world-class manufacturing (WCM) captures the breadth and the essence of the fundamental changes taking place in industrial enterprises very well. This infers that the companies must critically examine the competitiveness of their manufacturing strategies to achieve the status of a world class manufacturer (Haleem et al., 2012). Becoming a WCM company is a goal of industries. Hence, many among them are trying to adopt a philosophy of WCM in their production processes to be the best in the world within their particular sector of industry. Literature suggests that the WCM is the best alternative for implementation and to achieve or maintain competitive advantages (Okhovot et al. 2012; Fullerton et al., 2003). He further stated that the term WCM is applied for organizations that achieved a global competitive advantage through the use of their manufacturing capabilities. Firm should continue to demonstrate their excellence in manufacturing through dominance the world markets, to be called a world class manufacturer. Companies engaged in WCM implementation focus on improving operations, elimination of waste, managing

customer relationships, achieving green practices and creating lean organization. Just in time (JIT), manufacturing resource planning and total quality management (TQM) are all techniques to achieve WCM (Upadhye et al. 2010).

In this research, case study conducted at UPL which is one of the India's largest crop protection chemical company and the fastest growing in the global crop protection chemicals sector. UPL (incorporated in 1969) commenced with the manufacture of phosphorous-based industrial chemicals. Between 1980 and 2000, it diversified into crop protection chemicals and specialty chemicals. Between 2000 and 2018, it transformed itself from a local to global player with more than 25 international acquisitions. The core of the company's product selection has centred around products enjoying robust demand even after going off-patent. UPL markets products in 130+ countries (Annual Report 2017-18 of UPL). Vision of UPL is:
"To be a world-class organization by enhancing value for customers and other stakeholders, by caring for employees to inspire their engagement as a motivated team in an open and learning environment, by setting new performance standards and by focusing on total quality control, innovation and responsive care towards the environment."

In tandem with the vision to be a world class organization, UPL wants to challenge the Deming Prize through the application of Total Quality Management (TQM) in next 5 years' time. The Deming Prize is one of the highest awards on TQM (Total Quality Management) in the world that recognizes both individuals for their contributions to the field of Total Quality Management (TQM) and businesses that have successfully implemented TQM (Evans and Lindsay 1993). While keeping customer first at highest priority, vision/mission/goals at heart, the system, process & people at base to support the TQM implementation for WCM (Figure 1).

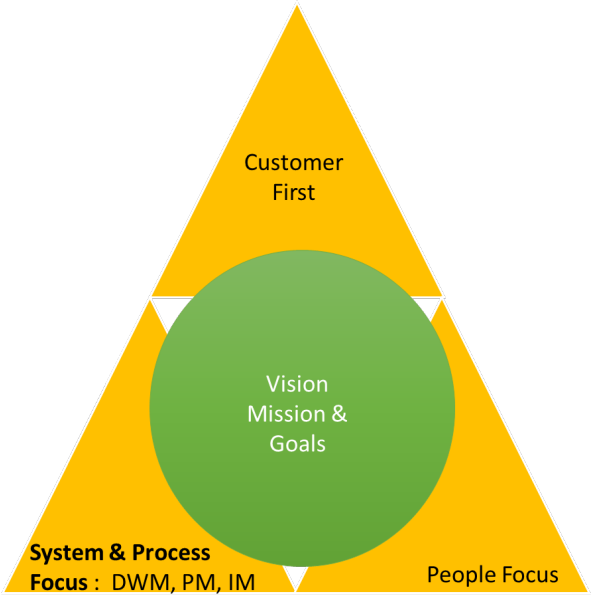

Figure 1. Priorities of Management (Source: UPL TQM Orientation)
DWM (daily work management), PM (policy management) and IM (improvement management)

The purpose of this paper is to provide guidelines to start the journey toward becoming world class manufacturing company through TQM. By that way, it could be useful to the professionals by providing insights of various tools and practices to adopt for improvement. Rest of the paper is organized as below. We introduced our organization and need behind becoming world class manufacturer in Section 1. WCM and various quality awards are explained along with its advantages for the organizations in Section 2. Relevant practices under WCM and TQM are initially identified and explained in Section 3. We have concluded the paper by summarizing the learning so far in Section 4. Whereas, future work is summarized in Section 5.

2. Literature Review

Manufacturing capabilities can be used as a strategic, competitive weapon. "Best practices" is one of the major manufacturing strategic paradigm, which is supported by the concept of World Class Manufacturing (WCM) (Fullerton et al., 2003). WCM represents a synthesis of various concepts, principles, policies and techniques for the management and operation of companies engaged in production (Dokic et al. 2012), in order to achieve competitive advantage. The primary goals are to continually improve the quality, cost, lead time, flexibility and customer service.

One of the most important trends influencing corporate decision makers over the past several decades has been the desire to pursue quality as a competitive advantage. It leads to enhance customer value, increase in customer satisfaction, reduced manufacturing costs thus higher profitability and market share. Hence quality award have been established to stimulate a greater interest in quality management, eg. the Deming Prize in Japan, the Baldrige Award in the U.S., and the European Prize. The winning firms of these awards are model enterprises having a competitive advantage over other firms in their industry. Although, there are several advantages perceived by winning a quality award, such as –

- Useful in public relations or marketing tool (Houston 1990)
- To have a superior management process in place giving them a competitive advantage that would allow them to survive economic downturns, shifts in technology, or changes in fashion (Garvin 1991)
- It leads to superior performance (Houston 1990)

3. Methodology

The three principles which drive WCM are summarized below

- Implementation of just in time (JIT) and lean management (LM) leads to reduction in wastage thereby reduction in cost.
- Implementation of total quality management (TQM) leads to reduction of defects and encourages zero tolerance towards defects.
- Implementation of Autonomous Maintenance (AM), Daily Work Management (DWM) and Total Preventive Maintenance (TPM) leads to reduce stoppage of production through mechanical/equipment failure.

3.1. Total Quality Management (TQM)

TQM can be defined as a holistic management philosophy that strives for continuous improvement in all functions of an organization, and it can be achieved only if the total quality concept is utilized from the acquisition of resources to customer service after the sale (Kaynak 2003). Organizations, challenging Deming Prize, has exerted an immeasurable influence directly and indirectly on the development of quality control/management. They should demonstrate effective quality management methods and established structures for implementation and put the methods into practice. Every factor such as the applicants' attitude toward executing Total Quality Management (TQM), their implementation status and the resulting effects are taken into overall consideration.

Initial step has been to study the current organization structure and then design the structure for institutionalization - two layer structure: Corporate central steering team at upper level, and Unit level team at second. Corporate central steering team to provide policy direction while unit level team to take up improvement initiatives.

3.2. Policy Management (PM)

Policy management, also called as a Hoshin Kanri, which is a systematic approach to organization-wide management based on the idea that unity and organizational purpose could be managed. It is a means to pull together the forces within a company and to unite the minds internally, to perpetually improve its performance by adjusting quickly to change (Witcher and Butterworth 2001). In Japan practitioners have claimed that Hoshin Kanri provides a basis for successful organization wide management. It includes the activities that are conducted with the cooperation of the entire company, to establish and efficiently achieve mid and long term business plans and short term business policies based on fundamental management policies. Organizations vision, mission and values becomes the basis for policy management.

WCM promotion and implementation program preparation has been made involving all employees. Followed by preparation of roadmap in line with company's long-term, mid-term and short-term plan. Micro-planning for short - term plan would be the next step, which would required weekly /periodic tracking for action progress.

Policy Management has been enterprise-wide activity and periodic reviews of plan an applying Plan-Do-Check-Act (PDCA) method would lead to successful achievement of various business goals. President's Policy deployment to Manufacturing, Sales & Marketing and subsequently to all functions creates synergy of purpose with actions, Policy

Management system has been very useful for business goal alignment and cascading Managing Points (MP) & Checking Points (CP) exercise which is to be carried out across functional team with clear operational definitions for each parameter. Tracking mechanism for the monthly progress is intended to be very helpful to check progress and to re-align it as per need, direction and adequacy of resources and infrastructure aspects.

3.3. Daily Work Management (DWM)

Daily work management has been a proven and widely used concept of ensuring that the daily activities are performed reliably. These activities are for which an individual is responsible and which are repeated regularly by some frequency. Daily management aims not only to maintain current level of performance but also to improve the performance gradually, where these activities must be performed regularly. Consistent quality, reduced cost of operations, enhanced confidence, improved employee safety and morale are few advantages of DWM. It is the natural tendency of persons to adopt quick fix approach and fire-fighting. By adopting DWM, these situations can be avoided by managing daily work, hence, the person can focus on improvement on daily basis on his/her workplace.

Key elements of the DWM process:

- Establishing roles and responsibilities
- Defining performance measures
- Setting standard operating procedures (SOP)
- Daily monitoring and control
- Standardize-Do-Check-Act (SDCA) and after stabilization
- Check scope for further improvement with Plan-Do-Check-Act (PDCA)
- Rotate SDCA-PDCA cycle
- First Time Right (FTR) approach

On daily practice, workers, middle management and top management have found very difficult to come out of their routine work due to fire-fighting on shop floors. Hence, little time they can devote to improvements and breakthrough ideas. Ideally as per DWM practice, workers who are mostly engaged in routine work must have little involvement in improvements. Middle management should focus on improvements more, so that little requirement at routine fire-fighting. Whereas, top management should focus on breakthrough ideas and improvements rather than routine work.
Daily Work Management (DWM) also utilize the MP-CP (Managing points and Checking points) concept where focus is mainly on bringing stability and reducing the variations from processes. Gemba (workplace in Japanese language) approach is very important for DWM. Operational team required to follow Gemba walk, so that they can identify the plant or functional issues. DWM also encourages to make the issue/problem bank by synthesizing the issues and action plan to resolve it. As problem solving has been very important mechanism here, using small groups, kaizens or quality circle teams could be engaged to solve routine problems. Whereas, for chronic issues forming a cross-functional team (CFT) and engaging it to resolve such issues has been more effective.

3.4. Autonomous Maintenance (AM)

TPM is a WCM initiative that seeks to optimize the effectiveness of manufacturing equipment (Ahja and Khamba, 2008). Autonomous maintenance is one of the pillar of eight pillar approach of TPM to address 16 losses quantified in it. AM is a tool to eliminate waste arising out of abnormalities in the equipment due to forced deterioration and bring equipment to its basic condition with involvement of people. AM is a mindset where individual preserving one's own equipment. There are seven steps of AM:

- Perform
- initial cleaning to eliminate dirt, dust, grime and expose all abnormalities
- Eliminate source of contamination
- Establish cleaning, inspection and lubrication standards
- Developing equipment competent operator for general inspection through training

- Developing process competent operator for general inspection through training
- Systemize AM through standardization
- Full self-management at circle levels

Autonomous maintenance has been started in UPL with the "My Machine Campaign", involving four steps:

- Training and preparation
- Initial cleaning, abnormality identification and tagging
- Implementing countermeasures for sources of contamination
- Developing tentative standards

Initially, the full-fledge rollout plan of AM has been prepared for the implementation for model machine. The sample is provided in Table 1. This plan would be imperative to demonstrate the rollout of AM for machines. Once, team gets confidence and hands on experience on model machine, horizontal deployment throughout the manufacturing unit would rather be very easy. The team involved in model machine rollout may extend training and know how to other members to expedite the overall implementation of AM. Face-lifting of model machine would also be critical to know the positive impact of AM, as well as to know the resources and difficulties involved while deploying it horizontally.

Table 1. Rollout plan of AM (Example of AM for Model Machine)

S.N.	Action Points
0a	Training Program on Autonomous Maintenance
0b	Workshop for Core group on Model Machine Campaign Roll-out
1	Setup the crew for MMC, for each of the three units
2a	Develop the Crew Training Plan
2b	Prepare the Crew Training Material
3	Communicate to all concerned about Crew Training
4	Conduct Crew Training
5a	Divide the total plant into "machines", by defining the boundaries of this machine
5b	Compile the list and map of such machines ie plant-segments into a plant-wise Equipment List
6a	Develop Criteria for selection of machine for MMC
6b	Sequence/prioritize the machines for MMC, using the above-developed criteria
7	Firm-up the machine/plant-segment for MMC
8	Collect technical information about the identified machine
9	Collect historical breakdown and other performance data for this machine
10	Prepare Training Material on "Know Your Machine" Workshop for training of crew on this machine
11	Conduct "Know Your Machine" Workshop for the Crew, on this machine
12	Prepare UPL Standard on "Plant/Equipment Abnormalities"
13	Prepare 'ready reckoner' of abnormalities
14	Prepare UPL Abnormality Matrix
15	Prepare UPL Abnormality Countermeasure Sheet
16	Design UPL RED and WHITE Abnormality tags
17	Print RED and WHITE Abnormality tags
18a	Firm up the date for the MMC and communicate to Crew and others as appropriate
18b	Update Preventive Maintenance checklist with "Do MMC" as an additional item.
19	Plan and arrange tools and other material (cotton waste, cloth, hand gloves, torch light, appropriate etc) required for initial cleaning
20	Allocate groups of crew members to different areas of the machine
21	Ensure that all required items are available with all crew groups
22	Ensure photography is arranged for and that the photographer is briefed on the role
23a	Conduct the MMC: Plant running
23b	Conduct the MMC: plant shut down
24	Create photo album after tagging, of 'before' + make a note of point of Photography (POP) that is angle, height, zoom, etc.
25	Plan for implementing countermeasures
26	Prepare MIS format for tracking of countermeasures on the red and white tags
27	Implement countermeasures on the abnormalities
28	Take photographs of the sample 'before' for the 'after' condition (ref. POP guidelines on point no-24)
29	Complete the photo album for 'before' and 'after'
30	Create Cleaning Standards, Lubrication Standards, Inspection Standards, Tightening Standards, One Point Lessons, etc based on learnings from MMC
31	Compile Tentative Standards Manual for the machine-**Operator**
32	Prepare training material for training on the tentative standards
33	Plan and implement trainings to all crew on the standards
34	Confirm improved machine condition and machine performance as outcome of MMC,as a prerequisite to handing over
35	Plan and implement Machine Handover Ceremony
36	After do- What Went Well (WWW) & What Went Wrong (WWW)-What Did not Go well

3.5. Improvement Management (IM)

Continuous Improvement includes the application of quality assurance to every company activity and is characterized by the application of good practice . . . the attainment of continuously improving customer satisfaction (McAdam et al., 2000). There are two different approaches of improvement, kaikaku: revolutionary change and kaizen: evolutionary change. Kaizen also called as continuous improvement, which is the ongoing improvement of products, services or processes through incremental improvements. QC story has been proved as a powerful improvement management tool from the perspective of quality. Seven steps of problem solving type QC story are:

i. Problem
ii. Observation
iii. Analysis
iv. Action
v. Check
vi. Standardization
vii. Conclusion

3.6. Lean Manufacturing (LM)

The philosophy of manufacturing pioneered by Toyota was termed as lean manufacturing by James Womack and Daniel Jones (1991) in the book *The machine that changed the world*. Lean manufacturing facilitates the production of artifacts in medium-to-large volume and a medium-to-large variety and hence enables to meet the requirements of a broad customer base. The basic concept of lean is to eliminate waste by addressing the material and information flow issues in a production system and makes it more efficient and competitive (Chaple et al. 2018a). Commonly referred wastes include overproduction, inventory, waiting, over-processing, transportation, motion and defects. Researchers have reported various benefits of lean manufacturing like, reduced waste, rework, space requirement, lot size, inventory, overhead cost and improved quality, motivation, process yields, productivity, flexibility and problem-solving capabilities (Jayaram et al., 2008; Hofer et al., 2012).

Within the process industry, chemical sector is under continuing pressure on the cost. However, lean has been the perfect strategy to apply to reduce cost. 'Performance improvements across the whole supply chain supporting increased business performance' is obvious offering of what 'lean' has to the process industries (Melton, 2005).

LM is a multi-dimensional approach that encompasses a wide variety of management practices in an integrated system. Researchers have discussed a wide variety of lean practices in improving the business performance. Lean practices are those actions that focus on the reduction of waste and non-value-added activities (e.g. overproduction, inventory or any other factor) that can disrupt the swift-even flow of goods through the supply chain, from a firm's internal manufacturing operations (Chaple et al., 2018b).

3.7. Performance measures (PQCDSM)

Performance measures are a metric used to quantify the efficiency and/or effectiveness of an action (Neely et al. 1995; Chaple et al. 2018a). Performance measures help in monitoring, achieving goals, benchmarking, and deciding strategies for corrective actions. It is reported that organizations that fail to measure the most critical areas for its success are less likely to achieve their strategic objectives. In measuring the benefits of implementing improvement initiatives, researchers have discussed a variety of performance measure, such as, productivity, quality, cost, delivery, safety and morale which are adopted to monitor improvements through WCM.

4. Conclusions

WCM is sustainable business excellence model driven by customer centric goals, people and partners. The case study presented in this paper intends to explain the implementation framework of World-Class Manufacturing (WCM) in process industry which can guide and support for those process industries, aiming to start their journey to reach world-class standards in total quality management (TQM). The various tools of TQM were then summarized and explained, such as policy management, daily work management, autonomous maintenance, and lean manufacturing. In the context of WCM implementation in a process industry, the study is considered to be valuable and useful to the practitioners as it first

a) Brings stability in processes and reduces variations, then
b) Takes system and processes to next level applying SDCA- PDCA cycle continuously, and overall
c) Profitable business goal achievement as the effect of robust system and processes.

5. Future Work

For the organization, this WCM journey is only a start and it is in initial phase. WCM implementation structure and promotions plans has been made by a core team. We can summarize the future work direction as below:

- Capability building – technical as well as adaptive,
- Deployment of framework with micro plan,
- SDCA- Standardize the executed work,
- Establish review mechanism, and
- Periodic plan-do-check-act (PDCA) actions.

Also, it is worth to mention that the continuous monitoring of performance measures to evaluate the impact of implementation of various WCM tools (like effectiveness of Gemba meetings, Gemba walks, SPC- Statistical process control, etc.).

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References

Ahuja, I. P. S., and Khamba, J. S., Total productive maintenance: literature review and directions, *International Journal of Quality & Reliability Management*, Vol. 25, No. 7, pp. 709-756, 2008.

Chaple, A. P., Narkhede, B. E., Akarte, M. M., and Raut, R., Modeling the lean barriers for successful lean implementation: TISM approach, *International Journal of Lean Six Sigma*, https://doi.org/10.1108/IJLSS-10-2016-0063, 2018a.

Chaple, A. P., Narkhede, B. E., Akarte, M. M., and Raut, R., Interpretive framework for analyzing lean implementation using ISM and IRP modeling, Benchmarking: An International Journal, Vol. 25, No. 9, pp. 1-40, 2018b.

Dokic, I., Arsovski, S., and Pesic-Dokic, Snezana, Quality and world class manufacturing, *6th International Quality Conference*, Kragujevec, June 08, 2012.

Evans, J. R., and Lindsay, W. M., Total Quality Management, *The Management and Control of Quality (4 ed.)*, Minneapolis, Minnesota: West Publishing, pp. 112, 1993.

Fullerton, R. R., McWatters, C. S., and Fawson, C., An examination of the relationships between JIT and financial performance, *Journal of Operations Management*, Vol. 21, No. 1, pp. 383-404, 2003.

Garvin, D. A., How the Baldrige award really works, *Harvard Business Review*, November-December, 1991.

Haleem, A., Sushil, Qadri, M.A. and Kumar, S., Analysis of critical success factors of world-class manufacturing practices: an application of interpretative structural modelling and interpretative ranking process, *Production Planning & Control*, Vol. 23, Nos. 10-11, pp. 722-734, 2012.

Hofer, C., Eroglu, C. and Hofer, A.R., The effect of lean production on financial performance: the mediating role of inventory leanness, *International Journal of Production Economics*, Vol. 138, No. 1, pp. 242-253, 2012.

Houston, P., Dubious achievement, Business Month, pp. 40-44, July, 1990.

Jayaram, J., Vickery, S. and Droge, C., Relationship building, lean strategy and firm performance: an exploratory study in the automotive supplier industry, *International Journal of Production Research*, Vol. 46, No. 20, pp. 5633-5649, 2008.

Kaynak, H., The relationship between total quality management practices and their effects on firm performance, *Journal of Operations Management*, Vol. 21, No. 1, pp. 405-435, 2003.

McAdam, R., Stevenson, P., and Armstrong, G., Innovative change management in SMEs: beyond continuous improvement, *Logistics Information Management*, Vol. 13, No. 3, pp. 138-149, 2000.

Melton, T., The benefits of lean manufacturing What lean thinking has to offer the process industries, *Trans IChemE, Part A, Chemical Engineering Research and Design*, Vol. 83, No. A6, pp. 662-673, 2005.

Neely, A., Gregory, M., and Platts, K., Performance measurement system design: A literature review and research agenda, *International Journal of Operations & Production Management*, Vol. 15, No. 4, pp. 80-116, 1995.

Okhovat, M. A., Ariffin, M., Nehzati, T., and Hosseini, S. A., Development of world class manufacturing framework by using six-sigma, total productive maintenance and lean, *Scientific Research and Essays*, vol. 7, no. 50, pp. 4230-4241, 2012.

Upadhye, N., Deshmukh, S. G., and Garg, S., Lean manufacturing for sustainable development, *Global Business and Management Research: An International Journal*, Vol. 2, No. 1, pp. 125-137, 2010.

Witcher, B.J., Butterworth, R., and Hoshin Kanri: Policy management in Japanese-owned UK subsidiaries, Journal of Management Studies, vol. 38, no. 5, pp. 651-674, 2001.

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