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UNDERSTANDING THE EFFECT OF LEAN SIX SIGMA COMBINATION

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ABSTRACT

Lean Six Sigma emerges as an impressive philosophy which can cope with latest challenges in an organization. This paper provides basic idea about combined effect of lean and Six Sigma concept and problem solving approach of lean Six Sigma. It also try to find difference in usage of Six Sigma approach and Deming's basic PDCA approach. The paper discusses the viewpoints of researchers about this field through literature review.

Keywords : DMAIC , Lean, PDCA, Six Sigma ,Wastes

I. INTRODUCTION

1.1 Lean Concept

Lean was introduced on the 1980s Toyota Production System. It is a well known management philosophy which basically focuses on getting right services and product at right places and time in the right quantity to right customer by minimizing unwanted wastes involved in the process and hence achieves perfect flow of work and flexibility in the system.

1.2 Wastes Required To Remove

Overproduction- Producing more than required
Transport- Unnecessary movement of materials
Waiting - Inefficient utilization of people and resources
Motion - ineffective people movement
Inventory – Unnecessary material laying around
Over processing – producing quality more than required by customer
Defects/ Corrections- Time spent in producing defective products
Underutilized people – Less dedication towards value addition process

1.3 Six Sigma Concept

It was first outlined by Motorola in 1985 as a statistical modeling of manufacturing processes Six Sigma is a managerial approach which seeks to improve the quality of process outputs by identifying and removing the causes of defects. Six Sigma approach is a collection of statistical concept and techniques that focuses on reducing variation in processes. In a process that has achieved Six Sigma capability, the variation is small compared to the range of specification limit. A Six Sigma process is one in which 99.9999966% of the products manufactured are statistically expected to be free of defects (3.4 DPMO (defects per million

opportunities).Six Sigma is a one of clever way of branding and packaging many aspects of Total Quality Management (TQM).

II. SIX SIGMA GOALS

• Minimize Variation: Process encounters fewer defects.

• Maximize Consistency: Products & services can be delivered reliably as expected .

Lean and Six Sigma complement one other

• Lean Optimizes Six Sigma

• A comprehensive tool set to increase the speed and effectiveness of any process

III. METHODOLOGIES OF SIX SIGMA

Six Sigma projects follow ***two*** project methodologies

DMAIC : DMAIC (Define, Measure, Analyze, Improve, Control) is used for projects aimed at improving an existing business process.

DMADV : DMADV(Define, Measure, Analyze, Design, Verify) is used for projects aimed at creating new product or process designs.

Basic Difference Between Lean and Six Sigma

Lean	Six Sigma
Focuses on waste reduction	Focuses on defect and variability reduction
It lacks quality as compared to Six Sigma	It thinks about ultimate quality level
Aims to reduce cycle time preferably	Aims to improve process capability preferably
It works on daily improvement basis	It is project based and uses statistical tools
Reduces inventory	Reduces waiting time

IV. SIX SIGMA ROLES

- **Executive Leadership**, includes the Chief executive officers and members of top management. They are responsible for building a vision for Six Sigma implementation.
- **Champions,** does duties for Six Sigma execution in the company in the coordinated manner.
- **Master Black Belts**, selected by champions which operates as in-house coaches on Six Sigma. They dedicate their full time to Six Sigma. They serves champions and trains Black Belts and Green Belts.
- **Black Belts,** functions under Master Black Belts to exercise Six Sigma methods.
- **Green Belts,** are the employees who take responsibilities of Six Sigma execution along with their job responsibilities, operating under the guidance of Black Belts.
- **Yellow Belts ,** comprises of most basic concept of Six Sigma methodology.

Tools , Techniques and Principles of Six Sigma and Lean

Six Sigma	Lean Production
Variabilitv reduction	Workplace management
DMAIC methodology	Pull system (Kanban)
Design Of Experiments (DOE)	Value Stream Mapping
Quality Function Deployment (QFD)	Just-in-Time (JIT)
Analysis of Means and Variance (ANOM & ANOVA)	Production flow balancing
Root Cause Analvsis	Kaizen
Process Mapping	Cellular manufacturing
Hypothesis tests	Waste identification and elimination
Robust Design	SIPOC process diagram
Belt system (MB, BB, GB, YB)	Set-up time reduction (SMED)
Statistical Process Control (SPC)	Total Productive Maintenance (TPM)
Process Capability Analysis	Mistake Proofing (Poka Yoke)
Project Management	One Piece flow (Takt time)

V. PROBLEM SOLVING APPROACHES IN LEAN SIX SIGMA

DMAIC Purpose: Its aim is to identify, minimize and quantify sources of variations and then improves and maintains performances with predefined control plans

DMAIC Goals- To Achieve customer utmost satisfaction, growth, minimize cost (productivity), and cash (working capital) and maximize productivity.

DMAIC Methodology

The DMAIC methodology is a ***five step*** approach to improve existing processes.

The five steps are: Define, Measure, Analyze, Improve, and Control.

5.1 Define: What is happening at present?

Purpose: defining and understanding the requirement of improvement of processes and developing a clear statement of the goal. This is documented in the form of a project charter, which answers following questions:

1. What is the **process**
2. What is the **scope** of this Project?
3. How is the project linked to the **business winning strategies**?
4. What is the process **defect**?
5. What is **causing** the pain?
6. What will be **measured** and how?

Tool Required: Brainstorming, Overall business map: SIPOC (Supplier, Input, Process, Outputs, Customers), Process Mapping which includes FMEA (Failure mode and effect analysis).

5.2 Measure: What are root causes of the defects?

Purpose: Focuses on improvement in effort of gathering information on the current situation.

1. Construct the process by mapping which helps to identify the inputs (X's) and outputs (Y's) of each step.
2. Employ a Cause & Effects Diagram to rate inputs (X's) against the key project outputs (Y's)
3. Gather relevant data to establish baseline performance of the process (project Y data).

Tool Required: Cause and effect diagram(Ishikawa diagram), Process mapping, Value stream mapping(from Lean concept)

5.3 Analyze: How to use data to understand the root cause?

Purpose: Find out the relationships between the inputs (X's) and outputs (Y's) and identify probable sources of process variability. Try to reduce the number of inputs (X's) to an important few and verify this with data.

1. Examine the root causes of the important inputs (X's) from the Cause & Effects Diagram with the Failure Modes & Effects Analysis (FMEA).
2. Gather Multi-Variable data on the process (using surveys, historical data or process observation).
3. Use graphs and statistical analysis to confirm or reject the Critical Inputs (X's) identified in the Cause & Effects Diagram and Failure Modes & Effects Analysis (FMEA).

Tool Required: FMEA, 5s (Sort, Systematic, Shine, Standardize, Sustain), Future state

5.4 Improve: What improvements can be put forward to eliminate the root causes?

Purpose: Authenticate the critical inputs (X's) and/or proposed solutions.

Identify and test possible improvements to certify the effect of each of the suspected inputs (X's) or to verify the efficacy of a proposed solution.

Tool Required: DOE (Design of Engineering) Planning, Kaizen (from Lean concept), Value stream mapping

5.5 Control: What controls are required to eliminate root causes permanently?

Purpose: Establish a plan to control the inherent inputs (X's) and monitor the process performance.

Evolve procedures and/or implement data monitoring to standardize any changes to the process and to ensure the process continuous performance level and Maintain the gain.

VI. DIFFERENCE IN USAGE OF PDCA AND DMAIC

PDCA V/S DMAIC

PDCA	DMAIC
Plan- Recognize the problem and formulate hypothesis	Define: Identify voice of customer and boundary of project
Do- Perform the experiment	Measure: Quantify collected data from previous step by using tools like pareto chart, Data mining, process capability
Check- Evaluate test result and come to conclusion	Analyze: Analyze causes of defects and variations by using brainstorming, cause and effect diagram and concept of design of engineering.
Act- Proceed according to above formulated solutions	Improve: Develop innovative alternative and implement using project planning and control tools
	Control: Control variation by doing failure mode and effective analysis(FMEA)

6.1 When Used

PDCA	DMAIC
Quick improvement is required	Process and product variation reduction
Low statistical training is required	High statistical training needed
Simple problems	Complicated problem
Incremental improvement occurs	Step wise improvement occurs
Low experimental cost with less failure cost	High experimental cost with higher failure cost

VII. LITERATURE REVIEW

There has been detailed discussion in the literature that many organizations have achieved significant cost savings through Six Sigma deployment (Motwani et al., 2004) [1]. There are also many evidences for Lean Six Sigma (Shah et al., 2008); Leipold [2], 2007[3]; Kumar et al., 2006 [4]; Does et al., 2009) [5]. It is ambiguous whether this impact has been short term or has been sustained in the long term. It has been suggested that Lean

Six Sigma can generally be fruitful if continued over a long period of time and it depends on the level of maturity of lean Six Sigma phases in an organization (Raje, 2009) [6]. Hence to adopt Lean Six Sigma as a solid data-directed approach to achieve greater quality performance in the long term. It has been recommended that a company must establish a exclusive amalgamation of resources and capability that pick up the benefits of Six Sigma (Huq, 2006) [7]. The competency-based viewpoint is based on the assumptions that a company required to have the assets, expertise and resources mandatory to perform some preferred activities in organized way in order to obtain a better competitive rank in the global market (Eriksen and Mikkelsen, 1996; Sanchez, 1996) [8]. According to these authors, the expertise have a intellectual aspect in terms of knowledge and intelligence the company possesses and an action aspect that enables a company to expand its competencies in integrated way. According to Huq (2006),[7] the competencies also include both personal and collaborative competencies. Personal competencies compose of technical knowledge and magnetism of the Six Sigma coordinator leading the Six Sigma or Lean Sigma formation. Corporate competencies composed of a combination of skills, knowledge and experience that empower a firm to implement a revised program profitably (Dunphy et al., 1997) [9]. These skills and technique are installed in a corporate environment and work methods and they can only evolve through persistent process improvement efforts (Huq, 2006) [7]. Organizations attains victory through the unified working of people, processes, and technology. The firmness of organization evolution lies in its origin in organization attitude and dynamics, and the application of action research to enhance human performance and organizational efficiency . Six Sigma provides advantages as a complement to adopt with other, less technical organizational advancement techniques when interferences are required to improve practical processes (Jeffery, 2005) [10].Hence it can be concluded that for Lean Six Sigma to be successful, it must have both technically and socially capable coordinators controlling the schedule and leading the improvement projects and the organization must have a unique combination of resources and competencies so that the business can be sustained for the long term (Huq, 2006) [7]. This is persistent with the classical human resources model which figure out an organization based on the three C's – competence , commitment and culture. There is need of Lean Six Sigma facilitators – to overthrown the mental barriers of implementing statistical analysis using the DMAIC methodology for continuous improvements within the workplace (Wiklund and Wiklund, 2002).[11] Competency-based viewpoint of success is where administrative commitment, open communication, employee empowerment and team structures stand in an organization (Powell, 1995) [10]. It sounds acceptable to conclude that these aspects are not dependent of the category of improvement program so would uniformly employ to Six Sigma and Lean Six Sigma (Naslund, 2008) [12]. Management expertise also includes the concepts of a learning organization, an ability to work in teams and an appropriate infrastructure to allow individuals to be creative and innovative (Huq, 2006) [7]. The expertise level of the Lean Six Sigma program promoter and the Black Belts that edge the projects are also critical to success (Pyzdek, 2009) [13]. A precise skill of a Lean Six Sigma program facilitator is an ability to impact cultural modification and workplace adjustment taking place from project improvement exercise and it would be linked to the seniority of the duties they act in the organization. According to Hooper (Hooper and Devine, 2002), [14] the quality specialist needs to re-design their role in an organization and shift from "quality control" to "philosopher of business strategy" and drive the assimilation of all quality operations , metrics, tools and accountancy systems to maximize the performance of all departments. This means that the duty of the deployment facilitator could take a high level or a low level depending on whether the role is senior and influential or less senior, perhaps more analytical and

less influential, respectively. Lean Six Sigma approach is being widely used in the hospital sector by focusing on the need to implement this tool to improve the value chain of healthcare (Aicha Aguezzoul, Aimé Nyoungue, 2012).[15] The main causes of the long lead-time are the subcontractors, the customers, and the company-implemented procedures. This can be identified and removed easily by using tools of lean six sigma like root cause analysis (T. M. Shahada, I. Alsyouf, 2012).[16] Lean Six Sigma can mostly help with process design and improvement, software development processes are substantially different from the processes in the other disciplines such as manufacturing or service operations (Kamran Ghane, Anagira, 2014) [17].The application of Lean Six Sigma (LSS) varies in different regions of the world in terms of both level of understanding and acceptability (Oviri Umude-Igbru ,Brian Price, 2015) [18] .

VIII. CONCLUSION

The comprehensive scrutiny of papers yields various ideas about emerging field of Six Sigma and benefits derived there off. Now-a-days concept of Lean Six Sigma has been used widely in the industries which also focus on elimination of waste in addition to reduction of defects .The technical and social aspects of the Black Belts provide the key basis for the layout of a Black Belt training and it should give focus for their training. It will be profitable to co relate the aspects of Black Belts with the training that they obtain to determine their competency. One may propose that the competency of the Lean Sigma professionals is partly due to the training and assessment that they have received. Integrating Six Sigma with Total Quality Management, Human Resource Functions, Lean Production, ISO 9000, ISO 9001, and the capability maturity model can be one of the key areas of interest for researchers and practitioners to maximize the positive effect of the Six Sigma method. Six Sigma and lean production are not an alternative for each other. They are complimentary to each other. The application of Six Sigma principles combined with the speed and agility of lean strategy will produce solutions in the never ending quest for better, faster, cheaper business processes. Lean Six Sigma project success is significantly affected by the competence of an organization and the competence of a Black Belt and/or Master Black Belt. The training of Six Sigma facilitators needs the involvement of academia in designing appropriate courses.

REFERENCES

[1]. Motwani, J., Kumar, A. and Antony, J. (2004), "A business process change framework for examining the implementation of Six Sigma: a case study of Dow Chemicals", The TQM Magazine, Vol. 16, pp. 273-83.

[2]. Shah, R., Chandrasekaran, A. and Linderman, K. (2008), "In pursuit of implementation patterns: the context of lean and Six Sigma", International Journal of Production Research, Vol. 46, pp. 6679-99.

[3]. Leipold, J.D. (2007), "Lean Six Sigma efforts near $2 billion in savings", Defense AT&L, Vol. 36, pp. 62-

[4]. Kumar, M., Antony, J., Singh, R.K., Tiwari, M.K. and Perry, D. (2006), "Implementing the Lean Sigma framework in an Indian SME: a case study", Production Planning & Control, Vol. 17, pp. 407-23.

[5]. Does, R.J.M.M., Vermaat, T.M.B., Verver, J.P.S., Bisgaard, S.R. and Van Den Heuvel, J. (2009), "Reducing start time delays in operating rooms", Journal of Quality Technology, Vol. 41, pp. 95-109.

[6]. Raje, P. (2009), Six Sigma Maturity Model, available at: www.isixsigma.com/library/content/c060911a.asp; http://ct.ctqmediamail.com/rd/cts?d¼55-844-121-96-57481-274088-0-0-0-1-3-572 (accessed 28 December 2009).

[7]. Huq, Z. (2006), "Six-Sigma implementation through competency based perspective (CBP)", Journal of Change Management, Vol. 6, pp. 277-89.

[8]. Eriksen, B. and Mikkelsen, J. (1996), "Competitive advantage and the concept of core competency", in Foss, N.J. and Knudsen, C. (Eds), Towards a Competitive Theory of the Firm, Routledge, New York, NY.

[9]. Dunphy, D., Turner, D. and Crawford, M. (1997), "Organizational learning as the creation of corporate competencies", Journal of Management Development, Vol. 16, p. 232.

[10]. Jeffery, A.B. (2005), "Integrating organizational development and Six Sigma: Six Sigma as a process improvement intervention in action research", Organizational Development Journal, Vol. 23, pp. 20-31.

[11]. Wiklund, H. and Wiklund, S. (2002), "Widening the Six Sigma concept: an approach to improve organizational learning", Total Quality Management, Vol. 13, pp. 233-9.

[12]. Naslund, D. (2008), "Lean, Six Sigma and lean sigma: fads or real process improvement methods?", Business Process Management Journal, Vol. 14, pp. 269-87.

[13]. Pyzdek, T. (2003), The Six Sigma Handbook – A Complete Guide for Green Belts, Black Belts and Managers at all Levels, McGraw-Hill, New York, NY

[14]. Hooper, J.A. and Devine,M. (2002), "Six Sigma strategies equate to new roles", Quality, Vol. 41, p. 8.

[15]. Aicha Aguezzoul, Aimé Nyoungue, "A preliminary analysis on Lean Six Sigma application in healthcare, Proceedings of the 2012 IEEE IEEM.

[16]. T. M. Shahada, I. Alsyouf, "Design and Implementation of a Lean Six Sigma Framework for Process Improvement: a Case Study" , Proceedings of the 2012 IEEE IEEM.

[17]. Kamran Ghane, Anagira, "A Model and System for Applying Lean Six Sigma to Agile Software Development Using Hybrid Simulation" , Proceedings of the 2014 IEEE IEEM.

[18]. Oviri Umude-Igbru and Brian Price , "Acceptability of Lean Six Sigma in a Developing Economy: Results from Exploratory Research in Nigerian Consulting Companies", Proceedings of the 2015 International Conference on Industrial Engineering and Operations Management Dubai, United Arab Emirates (UAE), March 3 – 5, 2015.