Business Excellence Using Various Lean Tools: A Review

Jignesh H. Acharya[1], Hemant R. Thakkar[2]
[1, 2] Dept of Mechanical Engineering
[1, 2] G.H.Patel College of Engineering & Technology

Abstract- *In today's era of mass customization &globalization, companies are required to provide products of good quality, faster delivery and at low cost to sustain in this competitive market. Lean tools help to achieve these by reducing/eliminating production wastes. Many more organizations are adopting lean tools to achieve competitiveness in the market. This paper discusses on some lean tools such as VSM, 5S, TPM, KAIZEN, KANBAN, CONWIP; their methodology to implement in different industries and benefits gain by same. This paper also includes their findings on lean tools.*

Keywords- VSM, 5S, TPM, KAIZEN, KANBAN, CONWIP

I. INTRODUCTION

Many manufacturers struggle with improving productivity, producing the right products or services at the right place and meeting on-time delivery. To survive in today`s era competitive world, manufacturers need to find new ways to reduce the manufacturing lead times in order to improve productivity and operating principle. Nowadays, it is targeted to improve the productivity performance by reducing the production lead time and production waste that are the most important goals for almost all manufacturing companies. Lean Production System (LPS) is the systematic approach of identifying and eliminating all wastages through\ continuous improvement to pursuit customer satisfaction. The primary goal of LPS is to reduce cost and improving productivity by eliminating major manufacturing waste in all work elements (Amir Azizia & Thulasi a/p Manoharan, 2015).Lean has been originally created and defined as the elimination of muda in the book 'The Machine that changed the world'. Toyota along with the support of Taiichi Ohno and Shingeo Shingo introduced a system to reduce or eliminate waste and non-value added activities from the process (Chandandeep Grewal, 2008).Lean manufacturing is a culture in which all employees continuously look for ways to improve processes (M. APREUTESEI et al., 2010). There are number of lean tools like VSM, 5S, TPM, Kaizen, Kanban, Poka-yoke, SMED, Heijunka, 5Ways, Cause and Effect diagram, JIT, Jidoka etc. Available to reduce/eliminate waste from production system.

This paper present review of literature on various lean tool like VSM, 5S, TPM, Kaizen, and Kanban different cases of implementation and innovation regarding above tools is studied. This will help student researcher for better understanding of these lean tools.

II. LITERATURE REVIEW

Value stream mapping

The original concepts and definitions given by Monden (1993) and Womack et al. (1990),about value stream mapping (VSM) demonstrated that it is necessary to map both inter-company and intra-company value-adding streams. Value stream refers to those specifics of the firm that add value to the product or service under consideration (Bhim Singh and S.K. Sharma, 2009). VSM is nothing but identifying VA& NVA activities in a particular process and eliminating NVA to achieve streamline flow of information or material from its origin to end point.

Step-by-step procedure to perform a VSM analysis. The first step consists in the selection of a product family as the target for the improvement and in the construction of the 'Current State Map' (CSM) for the selected product value stream. The CSM must be based on a set of data collected directly on the shop floor and should be drawn using the set of standard icons shown in figure 1.

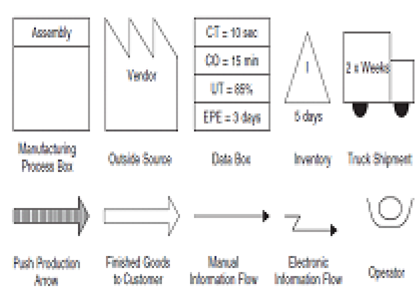

Fig 1. Actual state map icons (M. Braglia et al., 2006).

The next step consists in the identification and analysis of the wastes encountered along the value stream. Finally, a 'Future State Map' (FSM) is designed to represent the ideal production process without the removed wastes.

Also, the FSM should be drawn using a set of standard icons shown in figure 2, (M. Braglia et al., 2006)

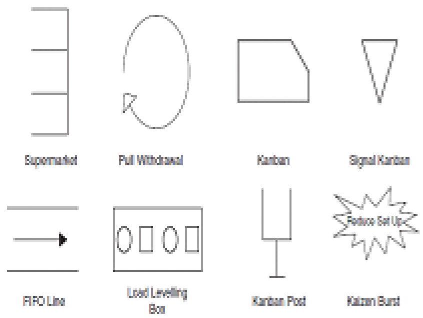

Fig 2. Future state map icons (M. Braglia et al., 2006).

Palak P. Sheth et al. (2014) implement VSM in automotive industry & they able to reduce non-value added time by 25.6%consequently WIP &66.7% lead time were reduced. Rahani AR &Muhammad al-Ashraf (2012) implement VSM in process industry and demonstrate that significant amount of the time products spent on the production system usually was waiting and non-value added& by implementing VSM total reduction of man time was at 15.99s or 16.9% while the machine time was reduced to 299.832s or 14.17% compared to original processing method is achieved. One Malaysian SME was able to reduce cycle time from 89.5to87.2 by implementing VSM & they use Kaizen &SMED to support the future state map(Amir Azizia & Thulasi a/p Manoharan,2015).Value Stream Mapping is one of the best tools to map a process and to identify its main criticalities. Unfortunately, it can be effectively applied to linear systems only. When the manufacturing process is complex with flows merging together; Value Stream Mapping cannot be used straightforwardly so M. Braglia et al. (2006) give an innovative framework to apply Value Stream Mapping to products with complex Bill of Materials is presented. The basic idea is to execute a preliminary analysis to identifythe 'critical production path' using the Temporized Bill of Material. Then, improvements are made considering all possible sharing with other secondary paths as possible constraints. Once the critical path has been optimized, a new path may become critical. Thus, the analysis proceeds iteratively until the optimum is reached and the Work In Process level has decreased under a desired value. Chandandeep Grewal (2008) conducted case study on SME at Ludhiana, India he gets 33.18% reduction in cycle time, 81.5% reduction in changeover time, 81.4% reduction in lead time and 1.41% reduction in value added time by implementing VSM. D.T. Matt (2014) proposes VSM for ETO environment. They identify 6 guidelines to develop future VSM.1. Identify merge-points in the current state map and introduce synchronization-areas in front of them.2. Combine machining processes with strongly fluctuating work load in one workshop area operated by a highly flexible workforce. 3. Split customer orders into suitable production orders, and release equal time increments of work. 4. Avoid crossings of material flows. 5. Flexibly assign assembly spaces in accordance with production progress, priorities and space requirements. 6. Avoid the storage of residual material near the machines and workplaces. Bhim Singh and S.K. Sharma(2009) conducted a case study on one of the company at Patiala, Punjab (India) and by implementing VSM they will able to reduce lead time by 92.58% and they also able to reduce inventory and man power. Satish Tyagi & Sarat Vadrevu (2015) use immersive virtual reality (IVR) to develop future state of VSM virtually without incurring extra cost. Satish Tyagi et al. (2014) implement VSM in product development process and thereby they get reduction in 50 % lead time. S. Vinodh et al. (2013) describe how to validate VSM practically and statistically.

The below graph shows % reduction in lead time achieve in various case study.

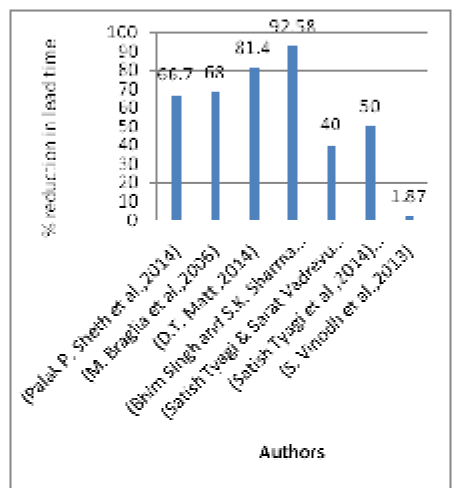

Fig 3. % reduction in lead time achieve in various case study of VSM

Total Productive Maintenance (TPM)

TPM is a Japanese philosophy. TPM has been developed on the basis of productive maintenance concepts and methodologies. This concept was first introduced by M/s Nippon Denso Co. Ltd. of Japan, a supplier of M/s Toyota Motor Company, Japan in the year 1971(Abhishek Jain et al., 2015).

TPM is based on eight pillars with a base of 5S. The goal of 5S is to create a clean and well-organized work environment.

Pillar 1: JH is mother pillar. It brings the ownership approach in the operator. Cleaning and maintenance is taken care by the operator himself.

Pillar 2: KK aims to identify and minimize waste, quality and manufacturing losses. Elimination of losses helps improving OEE.

Pillar 3: PM pillar deals with Preventive break down (Time Base Maintenance).It establishes Preventative and Predictive Maintenance systems for equipment and tooling. Effectiveness of maintenance department is increased to the point where 8 big losses are not generated.

Pillar 4: ET boost the moral and expertise of the operators and persons involved by to providing soft skill training and technical training.

Pillar 5: QM pillar monitors the factors affecting variability in product quality. It focuses to accomplish zero quality defects.
Pillar 6: IFC establish systems to shorten new product or equipment development prototyping lead time. Achieve stable commissioning of new product and equipment vertical start up.

Pillar 7: OTPM goal is to achieve zero functional losses, create highly efficient offices and provide effective service and support to other departments. Administrative and support departments can be seen as process plants whose principal tasks are to collect ,process, and distribute information. Process analysis should be applied to streamline information flow.

Pillar 8: EHS Assures safety and prevents adverse environmental impacts which are important priorities in any TPM effort. EHS achieve and sustain zero accidents, creates healthy, rewarding and pleasant workplace.

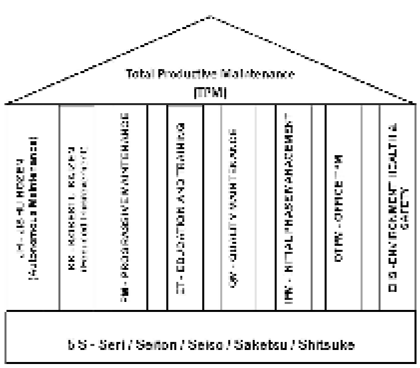

Fig. 4. TPM pillars (DnyandeoDattatrayaShinde&Ramjee Prasad, 2017)

Abhishek Jain et al. (2015) introduce mobile maintenance concept and implement it in one Indian SME & by introducing it OEE was improved by 20%. Dnyandeo Dattatraya Shinde & Ramjee Prasad (2017) gives ranking to 8 pillars of TPM according to their importance with respect to four parameters: Productivity, Cost, Quality and Delivery in Time, by using Analytic Hierarchy Process (AHP). They use questionnaire basedsurvey&9-point rating scale for AHP. Rajesh Attri et al. (2013) identified barriers for implementing TPM using questionnaire based Survey &ISM. They also identified enablers for implementing TPM using questionnaire based Survey & ISM. Hongyi Sun et al. (2003) run a pilot implementation of TPM in advanced manufacturing environment of a Hong Kong Manufacturing company & nearly 100% improvement in machine breakdown is achieved. Jyoti Prakas Majumdar et al. (2012) find various causes of failure behind successful implementation of TPM. They were classified into three major categories of problems or issues at three different stages: organizational issues during the foundation stage; TPM implementation issues during the formation stage; and operational issues during the TPM running stage. I.P.S. Ahuja& J.S. Khamba(2008). Find relationships between critical TPM success factors and key manufacturing performance enhancement parameters using questionnaire based survey on Indian industries. Jitendra Kumar et al. (2014) developed correlation between TPM program implementation and manufacturing performance. By surveying different industry Kanwarpreet Singh and Inderpreet Singh Ahuja (2014) describes how TPM alone or both TQM-TPM combined influence business performance. Transfusion of TQM-TPM initiatives can significantly contribute toward the better improvement of manufacturing performance in the organization, rather than TPM alone initiatives, also leading toward realization of core competencies for meeting global challenges (Kanwarpreet Singh and Inderpreet Singh Ahuja, 2014).

Table 1. quantitative improvement in different case studies of TPM

Authors	Parameters	Before implementation	After implementation
Abhishek Jain et al., 2015	Machine stoppage	216	2
Hongyi Sun et al., 2003	OEE	44.47%	65.12%
Kanwarpreet Singh and Inderpreet Singh Ahuja, 2014	OPE	50%	60%

Kanban

Fig. 1 shows the Kanji characters for Kanban. The first character – Kan – is made up of the symbols for hand and eye. It represents a man shielding his brow in order to see clearly, and means “to look at closely”. The second character – Ban – is made of the symbols for tree, wood, and wall. It represents a wooden board leaning against a wall, and literally means “wooden board”. In essence, then, Kanban means “to look closely at the wooden board” (Daryl J. Powell, 2018). In normal language Kanban means visual cards.

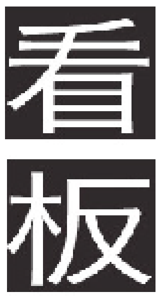

Fig. 1. Kanji characters Kan Ban (Daryl J. Powell, 2018)

Daryl J. Powell (2018) describes how to implement Kanban for Lean Production in High Mix, Low Volume, ETO Environments & he will able to reduce lead time by 50%. M. APREUTESEI et al. (2010) explain 6 rules of Kanban and problems what can be appear in a company because of the overproduction. Tim Haslett & Charles Osborne (2000) propose local rules and their application on Kanban to reduce total stock out hours. Result shows that stock out hours of 3 items was increased but total stocks out hours were reduced. F.T.S. chan (1999) describe how Kanban size will affect various performance measures in pull system single product & hybrid system single and multi-products.

Table 2. quantitative improvement in different case studies of Kanban

Authors	Parameters	Improvement
Daryl J. Powell, 2018)	Lead time	50%
Tim Haslett & Charles Osborne, 2000	Reduction in stock out hours	84%
F.T.S. chan, 1999	Fill rate	50%

CONWIP

CONWIP can be used in some production environments where Kanban is impractical because of too many part numbers or because of significant set-ups. By allowing WIP to collect in front or the bottleneck, CONWIP can function with lower WIP than Kanban. Also, CONWIP makes use of backlog of part numbers, which can allow job sequencing to be done by production control personnel(MARK L. SPEARMAN et al., 1990). In view of the dynamic nature of MTO environments ,CONWIP has been often stressed as a superior pull alternative to Kanban (Jing-Wen Li, 2010).

Kaizen

The word “KAIZEN” evolved from two Japanese words “KAI” and“ZEN”. “KAI” means “Change” and “ZEN” means “Better” so “KAIZEN” means “Change for the better” (Amit Kumar Arya and SurajChoudhary, 2015).

Amit Kumar Arya and SurajChoudhary(2015) implement Kaizen in small scale industry of India and able to reduce Inventory access time by 87 per cent and total distance travelled and total time taken by product is reduced up to 43.75 and 46.08 per cent, respectively. ViolettaGiada Cannas et al. (2018) use kaizen with complexity reduction method for assembly line balancing at chocolatier and confectionary company, Italy. 7 critical success factors for kaizen education and training in operators, communication process, documentation and evaluation of projects results, human resources integration, management commitment, and customer focus (Jorge L. García et al., 2013). Management commitment and Education and training are the basis or pillar for a successful kaizen implementation program and that its performance can be measured by best process, workers and customer satisfaction (Jorge L. García et al., 2013).B. Modarress et al. (2007) describe a method used to set kaizen costs at Boeing Commercial Airplane Company, IRC Division. Questionnaire survey in the case north Indian company was show that FMEA is most important element of kaizen (jagdeep singh jagoo & Harwinder Singh, 2016).

Table 3. quantitative improvement in different case studies of Kaizen

Authors	Parameters	Improvement
Amit Kumar Arya and Suraj Choudhary, 2015	Lead time	50%
Violetta Giada Cannas et al., 2018	Line balancing	60%
B. Modarress et al., 2007	Total processing time	-16.5%
JagdeepsinghJagoo&Harwinder Singh, 2016	Total efficiency	4.17%

III. 5S

5S stands for five pillars named in Japanese’s language: Seiri-Sort, Seiton-Set in order, Seiso-Shine, Seiketsu - Standardise, and Shitsuke-Discipline. Sort, the main S, is focused at eliminating the useless things not required for current operations at the workplace. Set in order concentrates to creating an effective storage method of items in order for easy usage, to find and put back to their places under labialized manner. Shine, the subsequent stage, is to altogether clean the work territory. Day by day follow-up cleaning is important to manage this change. Once the initial three of 5S have been executed, the next S,Seiketsu, is to standardize the best practices in the work zone. Discipline, the fifth S, calls upon adoption of correct and latest standardized methodology, and is often the most difficult S to execute and accomplish (Jugraj Singh Randhawa&Inderpreet Singh Ahuja, 2017).OlegheOmogbaia&KonstantinosSalonitisa(2017) investigate the short run dynamic implications of the sorting aspect of 5S using system dynamics. Promoting kaizen group activities, career development through training programs, and respect and care for people's comfort and safety, and establishing non-negotiable and clear rules. Most important principles associated with the success of the 5S (Carmen Jacaa et al., 2014).Jugraj Singh Randhawa&Inderpreet Singh Ahuja (2017) evaluate the quantitative and qualitative benefits accrued by an Indian automotive parts industry through strategic 5S implementation initiatives. Manuel F. Suárez-Barraza & Juan Ramis - Pujol(2012) find drivers and inhibitors responsible for enhancing or blocking the successful implementation of the 5S from cross analysis and established a conceptual framework. The 5S implementation leads to the improvement of the case company organization in many ways for instance. (1) Better usage of working area, (2) Work environment improvement (3) Prevention of tools losing. (4) Reduction in accidents. (5) Reduction in accidents. (6) Reduction in pollution. (7) Discipline in the employee. (8) Increasing of awareness and moral of employee. (9) Improvement in the internal communication. (10) Improvement in the internal human relation. (11) Decreasing of mistakes through error proofing (P. M. Rojasra & M. N. Qureshi, 2013).

Table 4. % reduction in lead time achieve in various case study of 5S

Authors	% Lead time reductio n
OlegheOmogbaia&KonstantinosSalonit isa, 2017	33%
Jugraj Singh Randhawa&Inderpreet Singh Ahuja, 2017	83.33%

IV. CONCLUSION& FUTURE SCOPE

From this literature review we find that average lead time reduction through implementation of VSM &5S is 57.22% & 58.165% respectively. Different case studies on TPM shows improvement in various parameters like Machine stoppage, OEE, OPE. By implementing Kanban improvement in Lead time, Reduction in stock out hours, Fill rate is possible. CONWIP generally more beneficial when no of parts are more, setup-time is more, MTO environment. By implementing Kaizen improvement in Lead time, Line balancing, Total processing time, Total efficiency is achieved in different case studies. To implement any of above Lean tool top management commitment is must without which business excellence is not possible. This paper helps student researchers, practitioners for better understanding of above Lean tools

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