

## An Explanatory Study of Lean Practices in Job Shop Production/ Special Job Production/ Discrete Production/ Batch Shop Production Industries

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### Abstract

In this paper, the study explores the benefits and advantages of Lean Practices or Lean Thinking in Job shop production/ Special job production/ Discrete production/ Batch shop production industries. The Lean Practices have been applied more compatible in Job shop production than in the continuous/ mass production because of several barriers and hurdles in the industrial context that influence the whole processes again and again, this happens due to the lack of knowledge about the wastes during the production of a variety of jobs or discrete manufacturing. This paper provides the guidelines to adopt and mentions to become Lean. In variety of production, it is very difficult to find out all the wastes during the processes from input to desired output, thus Lean techniques may be most suitable to minimize the wastage, time, inventory and assist to improve quality and become economical. These wastes may be managed by means of several Lean principles and techniques available. This paper gives a brief introduction of VSM, in order to recognize the opportunities for the various lean techniques, VSM is the main tool, especially it is used to observe the wastes and time spoilage through knowledge management.

**Key words:** Lean Manufacturing, Value Stream Mapping, Knowledge management, waste, value, flow

### I. Introduction

Lean manufacturing or Lean thinking approach was developed with the publication of the book "The Machine that changed the world" by the Womack, Roos and Jones (et al 1990). It is a reference to the Lean concept pioneered by Toyota. This book explores the additional to the Japanese production methods, concepts and studies as compared to traditional western methods; it also highlighted the superior performance to be Lean. Traditional manufacturing systems are built on the principle of economics of scale. The large fixed costs of production are depreciation intensive because of huge capital investments in high volume production. Due to high volume production there may be higher wastes. The follow on book Lean thinking: Banish waste and create wealth in your organization by Womack and Jones ( et al 1996). As an alternative to Batch-and-queue, high volume and inflexible operations, the principle of the Toyota production system (TPS) have been widely adopted in recent years even throughout the US. Application of TPS principles has brought to lean production which results:

- 1) Elimination of wastes
- 2) Smooth work flow across a wide variety of products

- 3) High quality output
- 4) Flexible operation
- 5) Lower total unit production costs

Lean manufacturing is one of the initiatives that many major industries ( manufacturing, fabrication, process, chemical, hospitality, health and food industries) in the Us as well as rest of the World have been trying to adopt to remain competitive in an increasing global market. But if you talking about people who working in these industries can truly say that they have idea about Lean? And the reply will be not many. The focus of Lean approach is on cost reduction by eliminating Non-value added activities and many of the tools and techniques of Lean manufacturing (TPM, JIT, Cellular manufacturing, Kaizen, production smoothing) have been widely used in discrete manufacturing. But in the beginning- the Birth of Lean was in Japan within Toyota in the 1940s. Taiichi Ohno had started work on the TPS in the 1940s and continued its development into the late 1980s by the advancements in computers which had allowed mass production to be further enhanced by the MRP systems. In 1970s Toyota's own supply base was also Lean. On the other hand, application of Lean manufacturing in the continuous process sector have been far fewer( Abdullah and Rajgopal et al 2003) because such industries are inherently more sufficient and have a relatively less urgent need for

major improvement activities. However Lean manufacturing becomes a paramount of all the recent methods of improvements to the manufacturing industries, Lean thinking (Womack and Jones, 1996) always aided us to understand the principles of the Lean:

- 1) The identification of value
- 2) The elimination of Waste
- 3) The generation of flow.

## II. Knowledge Management

For the installation of Lean, basically required the knowledge transmission in the system and among the people. Here the knowledge is meant by the reorganization of the both, the teams operational and management level. Thus the knowledge management is handled by the CFT (Cross Functional Team). A well managed knowledge transmission is critical to the sustainability of change.

Wastes: any activity in a process which does not add value to the customer is called waste. And it may be necessary part of the processes and sometimes it is observed that during the production many wastes always happened, Japanese describe seven wastes called as TIMWOOD.

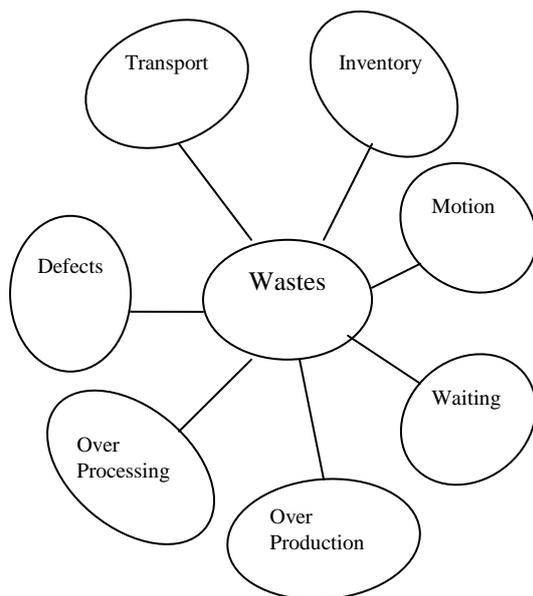


Figure: 1

**Flow:** Flow is one of the critical to understand different wastes as lean point of view. To understand

flow, you need to analyze the concept of value stream.

**Value:** Value is related to the customer. The identification of value is the very initial point to manage.

## III. Literature Survey

As the evolution of lean manufacturing was started in Japan after World War II, Toyota Production System (TPS) emphasized on elimination of wastes and Non-value added (NVA) activities. TPS's Chief Engineer Taiishi Ohno developed Lean Concept in 1940. Womack, Roos, Jones (1990) studied the implementation of lean manufacturing practices in the automotive industry on a global scale. In 1996 Womack and Jones helped us to understand the principle of lean (value, waste, flow). Further Womack and Jones (2003) defined 5 lean principles: Specifying value, identifying the value stream, flow, Pull system, and perfection. The successful application of various lean practices has been documented in a variety of industries, such as aerospace, computer manufacturing and automotive assembly (Mac Duffie, Sethuraman, and Fisher 1996; Laughnin 1995; Houlahan 1994). James- Moore and Gibbons (1997) determine that the level of lean manufacturing adoption in the aerospace industry was lower than expected as a result of high product mix and low volumes. Previous research has also identified the management of human resource as significant issue in the implementation of Lean (Agraval and Graves 1999; Bambar and Dale 2000; Nicholas 1999; Yauch and Steudel 2002). Product designers, process engineers and workers are isolated functionally, geographically or across organizations, decentralization of authority become more challenging, and the ability to effect change through continuous improvement activities is more difficult. This can also hinder Kaizen (continuous improvement) activities, which are foundational to lean (Detty and Yingling 2000). Lean production has now expanded and Lean thinking has been applied to all aspect of the supply chain. Lean thinking to business process has been well explained by the Melton (2003 & 2004). JIT is a technique of Lean was developed through its levels by Fullerton, Mcwatters and Fawson (2003). TPM, TQM and Human resource management was well analyzed by Shah and Ward (2003). There are many other researchers and practitioner may be reviewed to identify a complete set of lean practices and existing research instrument that might be leveraged for the study.

## IV. Background

A Brief overview may assist to explore the benefit of the lean principles followed by some

background information on discrete manufacturing or Batch shop production where the work was conducted.

**Lean manufacturing and its tools:** After World war II Japanese manufacturers were faced with vast storage of men, material and money. These conditions resulted in the birth of lean manufacturing concept (Taiichi Ohno et al 1994). Japanese industrial leaders such as Kiichiro Toyoda, Shigeo, Shingo and Taiichi Ohno responded by devising a new disciplined process oriented system which is known as the TPS or Lean manufacturing.

Key tools of lean system may be given as followings:

**Kanban:** A visual signal to support the flow by pulling product through the manufacturing process.

**Just- In-Time (JIT):** A system where customer requirement is fulfilled by transmitting the demand from the final assembly of the desired product all the way to raw material by pulling all the requirements just when they are required.

**Total Preventive Maintenance (TPM):** It referred to the regular equipment observation to detect anomalies so that the breakdowns may be prevented by proper monitoring.

**5S's:** A visual housekeeping technique developed by Japanese to maintain working shop floor.

**Total Quality Management (TQM):** This lean technique is focused on customer demand for the continuous improvement by means of Employee involvement and training, problem solving teams and statistical analysis.

**Cellular Manufacturing:** for similar product, processes are managed into cells which are intended to arrange easily facilitation of all the processes within these cells.

**SMED (Single Minute Exchange of Dies):** A changeover reduction technique.

**Poke yoke:** An error-proofing technique.

**Setup time reduction:** Continuously try to attempt the setup time reduction on a machine.

**Visual control:** A method of measuring performance at the shop floor.

## V. Overview of VSM

Value Stream Mapping is a technique to represent the flow of product manufacturing along with adequate information. VSM is a collection of all activities (value added as well as Non-value added) needed for the conversion of raw material to desired output and ending with customer. Thus recognizing Non-value added activities is VSM's main function. These activities consider the flow of both material and associated information within overall supply chain. The ultimate goal of VSM is to identify all types of wastes across each step (Rother and Shook et al 1999). Thus VSM is intended to provide the opportunity to understand the selection of suitable Lean technique. For implementing the Lean concepts, a map provides a blueprint by illustrating how the flow of material and information should operate. VSM also helpful to develop the following features:

- a) Flow Visualization (to understand the complex activities)
- b) Identify where waste occurs ( to understand the most suitable lean techniques)
- c) Integrated the Lean manufacturing principles ( for having the better solutions)
- d) Decide the implementation team (evolution of forces to be Lean)
- e) Relate properly information an physical flows.

Visualizing the flow creates the ability to understand where, when and how the product flows associated with its adequate information. Moreover VSM may be divided into two components big picture mapping and detailed mapping. Big picture mapping includes five phases:

- a) define customer requirements
- b) map information flows
- c) map physical flows
- d) link physical and information flows
- e) Complete the map by using icons and symbols. And include a time line of total lead time v/s value added time.

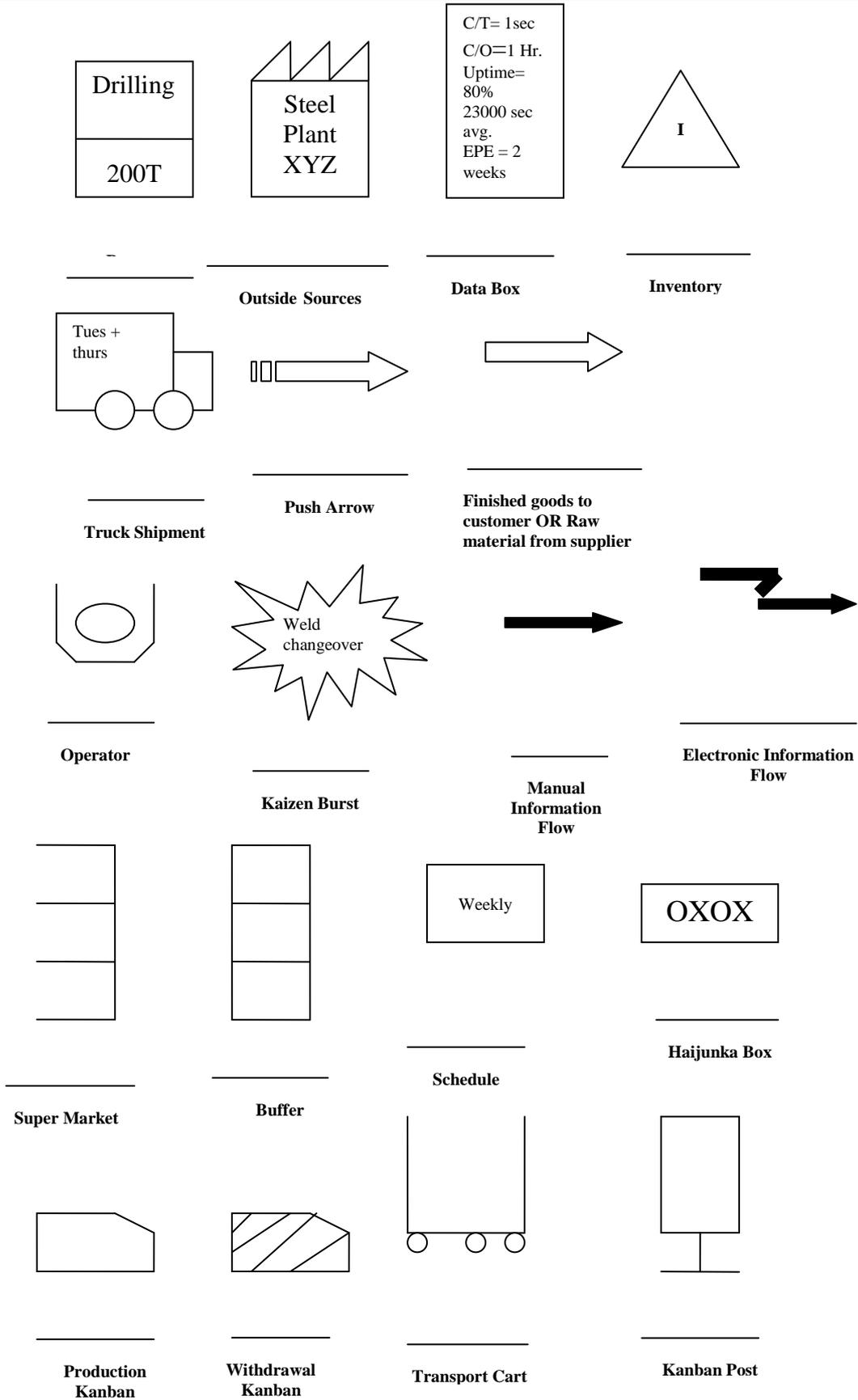


Figure: 2

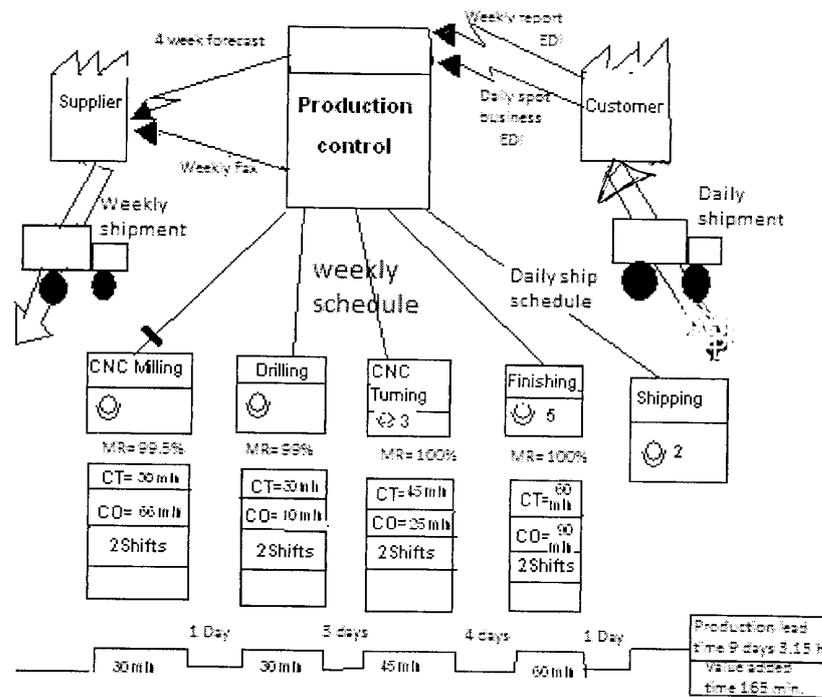


Fig.3 Current state VSM of transfer line

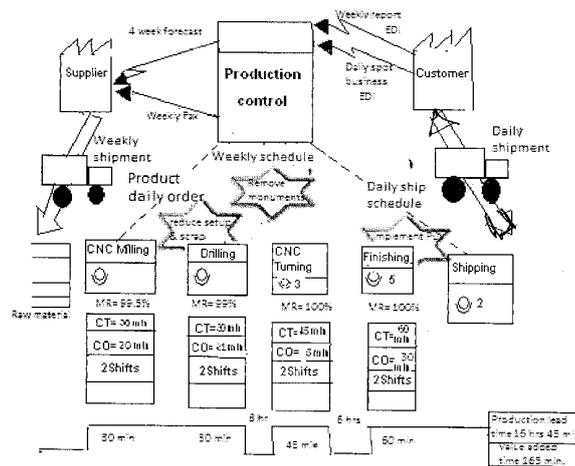


Fig. 4 Future state value stream map of lean production line

Physical flows are dealt with inbound raw materials and processes. For incoming raw materials information on demand number of deliveries,

delivery quantities, packaging and lead times is collected. Internal processes use information concerning the key steps within the organization,

processing time, and machine down time, inventory storage points, cycle time, setup time, number of operations and number of workers, rework, and quality inspection. Through mapping of value stream, a current state of whole process from raw material to finished product may be obtained. For a mass production all the steps of processes remains same, so it may be easily clarified where, when, and which kind of wastes are happened to eliminate. Thus VSM technique is more effective for job shop production/ Special job production/ discrete production/ batch shop production. To complete the map, a time line is used at the bottom of the map to analyze the value added time and production lead time. Detailed mapping is done after the completion of big picture map. There are few questions based on issue related to the construction of the future state map. They help to define non mapping details such as production mix, order release time and also assist to improve the quality of product as the introduction of Kaizen. As far as job shop is concerned detailed mapping provides the guidelines to identify the wastes through some specified VSM tools such as process activity mapping, supply chain response array, production variety funnel, Quality filter mapping, Decision point analysis, Demand amplification mapping, Physical structure mapping and research is continuous going on to provide more effective tools to find most effective results for a wide range of variety products. Thus cross functional team is very useful for knowledge transmission for such a variety of products Future state value stream map of lean production line may be shown in figure 4 and questions for future state mapping may be given as in

table 1.

Terms	Future state questions
Basic	1. What is takt time? 2. Will production be directly to shipping or to a finished goods? 3. Where will production need to use pull system? 4. Where can continuous flow be utilized? 5. What will single point in production chain will be used to schedule production?
Heijunka	6. How will the production mix be leveled at the pacemaker process? 7. What increment of work will be consistently released from the pacemaker process?
Kaizen	8. What process improvements will be necessary?

The Lean Enterprise Research Center (LERC, 2004) at Cardiff Business School highlighted that for the most production operations:

- 5% of activities add value
- 35% are necessary non value activities
- 60% add no value at all.

Therefore, no doubt that the elimination of wastes represent a huge potential in terms of manufacturing improvements – the key to success in such a competitive global market. The lean implementation team is forced to map the lean with consideration of all six major areas with corresponding lean practices for the evaluation to become Lean. The forces for driving a change to lean may be given as:

- The need to fulfill the consumer demand in an increasingly competitive environment.
- The need to be compliant in an increasingly regulated environment.
- The potential benefits:

Customer: Better understanding of consumer requirement

People: Empowered multi-skilled team at all levels of functional management & supporting staff.

Quality: More robust processes with lesser error (Quality improvement, assurance and control)

Financial: Reduction in operating costs, huge capital avoidance.

**Knowledge:** A well managed value stream refers a better system of transmission of knowledge.

Although there are several benefits of being Lean are reduce inventory, lead time, rework and process wastages and increase savings, process understanding, yet to become lean is very difficult job. Taiichi Ohno who was Architect of Toyota Production System stated “ Lean methods are so hard that companies will only try them when they are desperate”. We have some data, given by LERC (Lean Enterprise Research Centre) March 2009- Lean training and support results:

- 1) 40% of respondents (out of 37 recipients) reported no change in their training activity this year.
- 2) 43% of respondents reported a reduction in training activity.
- 3) 8% of respondents reported an increase in training activity.
- 4) Most respondents we are looking for lean courses on lean tools and techniques and strategy/ leadership rather than consultancy, monitoring or network membership.
- 5) 37% though it was important that short courses were accredited, 30% thinking it was quite important and 30% thinking it was not important.

This data shows that very few manufacturers are desperate to become Lean due to the lack of knowledge about the wastes and the non-value added activities. Through this paper one can understand how much financial as well as technical benefits may force Job shop production/ Special job production/ discrete production/ Batch shop production industries to adopt Lean Practices.

**Mapping of Lean Manufacturing Practices to six impact areas: (Table: 2)**

Impact Areas	Lean Practices
Customer Relationship	<ul style="list-style-type: none"> <li>• Customer requirement</li> <li>• Product analysis</li> <li>• Product customization</li> <li>• Product improvement</li> <li>• Demand stabilization</li> <li>• Delivery performance</li> <li>• Value enhancement</li> </ul>
Supplier Relationship	<ul style="list-style-type: none"> <li>• Supplier evaluation</li> <li>• Long term relationship</li> <li>• Cost estimation</li> <li>• Well communication</li> </ul>
Product Design & Development	<ul style="list-style-type: none"> <li>• Product development based on reliability and consumer utility</li> <li>• Design for manufacturing</li> <li>• Parts standardization</li> <li>• Consideration of new techniques such as concurrent engineering, reengineering, Business process reengineering</li> </ul>
Workforce management	<ul style="list-style-type: none"> <li>• Employee evaluation</li> <li>• Total involvement</li> <li>• Pay for performance</li> <li>• Multifunctional workforce</li> <li>• Work delegation</li> <li>• Reward for employee</li> </ul>
Shop-floor management	<ul style="list-style-type: none"> <li>• Lot size reduction</li> <li>• Pull flow control</li> <li>• Production scheduling</li> <li>• Housekeeping (5s')</li> </ul>
Manufacturing process and equipment	<ul style="list-style-type: none"> <li>• Setup time reduction</li> <li>• Lead time reduction</li> <li>• Cellular manufacturing</li> <li>• Work standardization</li> <li>• Mistake or error proofing (Poke-Yoke)</li> <li>• Value recognition</li> <li>• Total Productive maintenance</li> <li>• Total Quality Management</li> <li>• Cycle time reduction</li> <li>• Shop-floor organization</li> </ul>

These are six impact areas to implement Lean practices. As far as job shop production is concerned, it is difficult but essential to implement Lean with the consideration of all six impact areas for the survival of the industry in such a competitive global market to satisfy the consumer. Now-a-days consumer is the priority for any kind of industry. And it is well known that the Lean thinking is always focused on customer, thus Lean has adaptability in several new fields including the traditional fields of manufacturing, fabrication and automobile industries.

**Table: 2** provide the guidelines to Lean implementation team through mapping.

In table: 1 the eight questions are given which must be answered to construct the future state map. The first five questions are concerned with basic issues related to the construction of the future state map. The next two questions deal with technical implementation details of the control system (e.g. Heijunka). Ultimately last question in table is related to assist in the quality improvement and to the definition of actions needed (Kaizen) to migrate from the current state to the future state. The final step in the VSM process is to develop an action plan to implement the future state. VSM also provides the information that can be used to conduct economic justification analysis of the Lean manufacturing cell. Now-a-days there are many value stream mapping simulation available. In general we need a complementary tool with VSM that can quantify the gains during the early planning and assessment stages. An obvious tool is simulation, which is capable of generating resource requirement and performance statistics whilst remaining flexible to specific organizational details. It can be used to handle uncertainly and create dynamic views of inventory levels, lead times and machines utilization for different future state map. This enables the qualification of payback derived from using the Lean principles. The information provided by the simulation can enable management to compare the expected performance of the lean system relative to that of the existing system, it is designed to replace (Detty and Yingling, 2000) and assuming that this is significantly superior, it provides a convincing basis for the adoption of lean. It may be concluded that some forces that supporting Job shop production/ Special job production/ discrete production/ Batch shop production industries for being Lean are:

- 1) In such an increasingly competitive environment to fulfill or to get closer to customer demand.
- 2) For always being compliant.
- 3) For the potential benefits.

## VI. Contribution of Study

This study helps to understand the foundational approach to implement the Lean and also assist to know the differentiation among Job shop production/ Special job production/ discrete production/ Batch shop production and Mass production regarding their wastes and imperfections. This study explores, how value stream mapping is worthy to create the opportunities to use the various Lean techniques by understanding the respective losses wastes during the each step of whole process starting from the raw material and ending to the customer, by means of this paper researchers and practitioners can have the fundamentals in the implementation of Lean and through the deep assessment incredible results and data may be predicted very closer to real results after the implementation of Lean it also enables one to analyze the benefits of Lean manufacturing for various sectors such as manufacturing, fabrication, process, chemical, hospitality, health and food, electronics industries.

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