Review of Literature

Exhaustive literature review is done through available secondary sources like books, journals, monographs, reports, magazines, newspapers and online sources. The aim of the literature review is to understand Lean manufacturing, its origin, conceptual development, definition, its present status and practices adopted by firms. The various lean tools are studied in detail, to assess the dimensions that lead to effective implementation of lean and its relationship with firm performance.

In this chapter manufacturing industry is discussed in detail to provide a clear picture about the industry and the importance of lean practices in Indian manufacturing industry. The objectives of literature review are:

- To study the evolution of lean, its definition and various dimensions of lean,
- To identify the various dimensions, which helps in successful implementation of lean
- To study the role of lean practices on firm performance
- To identify the literature gaps related to lean implementation in a firm and its relationship with firm performance

2.1 Overview of Manufacturing:

Manufacturing is the backbone of any developing nation. A country’s level of manufacturing activity is an indicator of economic health. Generally it is presumed by economists, that the higher the level of manufacturing activity in a company, the higher the standard of living of its people (Kalpakjian and Shmid, 1991). The term “manufacturing” is derived from the Latin word, manufactus, meaning made by hand. In the modern sense, manufacturing involves making products from raw materials by means of various processes, machinery and operations through a well-organized plan for each required activity. In the twentieth century two major manufacturing revolutions have been
introduced. Both revolutions have been developed at the automobile sector. The first revolution was mass production. In the 1900s the demand for cars has raised dramatically, and the automobile sector has become very competitive. Craft production has dominated the automobile sector; in fact using of the craft production was inadequate to manage the high demand at that period. In that era, very high qualified workers were spending a long time to produce a single vehicle. This has affected prices and annual production rate of vehicles. The weakness of the craft production system has inspired Henry Ford to develop the first manufacturing revolution (mass production). The mass production has provided sufficient number of identical cheap vehicles. The second revolution was Toyota Production System (TPS). Lean was a new thinking way which has grew up at the Toyoda family company (Toyota house). Lean philosophy was driven by some main ideas as: customer values, eliminating non-value added activities and wastes, and work force ideology by involving the people in the production process to become a part of the community. This chapter will illustrate and discuss the journey of lean. It started by brief historical review of the main manufacturing events. Then it demonstrates lean principles and concepts, and lean problem solving methods. Finally it argues deferent methods of lean implementation and the main barriers that may occur during the implementation process.

2.1.1 Evolution of Manufacturing Management:

Modern manufacturing started in 1911 when Frederick Taylor published his theory Scientific Management. Scientific management has perfected the idea of pin factory which was included within the work of Adam Smith. In 1776 Adam Smith published "The Wealth of Nations". The theme of (pin factory) was to divide and associate labors with a specific production activity. Furthermore, Smith has mentioned that individuals act and contribute within the production process based on self-interests (Liker, 2004). The principles of scientific management were centralized on application of scientific methods to manpower's management in order to improve and optimize productivity. These principles can be summarized as:

- Developing scientific methods for each task in order to standardized the work and replace rule-of-thumb work method.
- Scientifically selection, training, and development of workers rather than
passively leaving them to chose their tasks and train themselves,

- Cooperation between management and workers to ensure that the scientific procedures are followed in order to accomplish the specific task, and
- Equate dividing of tasks between workers and managers, where each group are responsible for specific activities within the organisation (Taylor, 2006).

Implementation of these principles had improved the productivity dramatically and had substantial impacts on industry sector; however attention was drawn towards the negative side of Taylor’s theory, which included impersonal organizational environment. The main criticism of this theory was that Taylor treats human resources as machines who are only motivated and satisfied by money. In addition, situations of complexity and isolation have grown, because of departmental strategy. Number of researchers has been guided by these concerns in order to study and examine differences and the conflicts between human behaviours and management missions (Hopp et al, 2001 and Anderson, 1983). For example (Ratnayake, 2009) has reported that the Hawthorne studies have illustrated how work groups provide either effective support or horrific resistance to schemes of increase output which have planned by bureaucratic management. This study has argued that social factors had a positive influence on work behaviour and human not only respond to classical motivations as suggested in the scientific management approaches; however workers were interested in the rewards and punishments motivations. The Hawthorne study suggested that organisation to be considered as social system rather than a formal arrangement of functions only.

The Hawthorne study has concluded that:

a) High productivity is resulted from work satisfaction,

b) Social factor has a strong influence on motivation,

c) Sufficient levels of communication and cooperation among the organisation will increase the productivity, and

d) Money and management are not the most effective motivational factors.
These studies added much to the knowledge of human behaviour in organisations. Hawthorne studies have created pressure for researchers to explore and examine new motivational manners instead of traditional once (Baker 1999, and Arai 1998). Numerous motivational theorists have been published, each has described and analysed the motivational states from different approaches. Some theories view the motivation as generalised drive state without any specific direction or aims. While others preserve motivational states being specific to particular drives and needs. Therefore, motivations must be analysed in terms of specific goals and direction. People differ in their responses to the motivational state according to their needs and satisfactions for example what motivates one person might not necessarily motivate another. Furthermore, what motivates one person at one time may not motivate him at a different time. Involvement and process improvement team are the main factors for making the transition into lean organization easy and successful. By the end of the First World War the manufacturing’s philosophy has witnessed fundamental changes, since the elimination of craft production to be replaced by mass production system. Henry Ford has developed the concepts of mass production in order to produce large quantities of standardised goods. By using mass production system in his car assembly lines, Ford has become able to produce cars in high volume at very low costs. Mass production system characterised by producing high volume / low variety products using expensive inflexible machines and unskilled people (Holweg 2006, Duguay et al 1997).

### 2.2 Lean Production:

Lean production is a dynamic system that requires fewer resources (material, labour, overhead) and brings better outputs (quality, variety, cost & safety) to add value. Most of the works that has been done in lean manufacturing was based on the these approaches: (a) In Lean Thinking (1996) the goals of lean principles (specifying value, value stream identification, flow, pull & perfection) introduced by Womack & Jones’s (b) The Machine that changed the world (1990) by Womack, Jones & Roos’s talked about lean enterprise activities (design, manufacturing, supply & customer relationship) & (c) technological and human elements introduced by Monden’s (1983) & Ohno’s (1988) Toyota Production system. Monden’s work on TPS talks about (autonamation, Just in time, flexible workforce
Ohno’s talks about improvement activities, teamwork, 5 whys, Kanban system, standard operations, production smoothening etc. All the later work done by various researchers on lean manufacturing were based on these three models by keeping into consideration the human & technological system since these elements can be grouped in & addresses common techniques. The major difference between Monden’s (1983) & Ohno’s (1988) model of TPS is that both talked about the combination of technological & human elements required for lean production but Monden’s work overlooks the workforce capabilities that ensures long term improvement, on the other hand Ohno talked about teamwork, problem solving approach through 5 whys. The work done by later researchers during 1990’s there model shows determinants of a lean system in a manufacturing company across cross functional areas (lean development, lean procurement, lean manufacturing, lean distribution) (Karlsson and Ahlstrom, 1996). Oliver, Delbridge and Lowe (1996) framework was based on cross sectional study & tries to find out the relationship between lean manufacturing & performance outcomes & for this purpose the basically split the organization into inside (lean manufacturing) & outside (lean supply) the factory. Jenner (1998) proposed a framework of seven principles of lean system which is further extension of the previous work of Womack’s model. His work emphasizes more on human element of lean production which was missing in others work. Rasch (1997) work on small suppliers of automotive component parts & his work is based on two subsystems: a supplier system & core production system. James-More & Gibbons (1997) talked about elements like high yield, short product development time & financial optimization which can be regarded as outcomes rather than elements for implantation of the lean enterprise. Lewis (2000) differentiates between Lean production as an outcome & as a process, improved performance cannot be achieved only by lean production but to attain core goals of lean production workforce capabilities should also be considered. Nightingale & Mize (2002) study the effectiveness of the lean enterprise tools among the US & UK enterprise & proposed a roadmap that combines lean principles with strategic and structural issues in a dynamic sequence of three cycles (a) strategic planning for adoption of lean paradigm (b) creating an environment for implementation of lean principles (c) transformation or execution of lean principles to make a lean structure. Shah & Ward (2003) framework consists of four “bundles” of interrelated and internally consistent practices; these are Just-in-Time, Total Quality Management, Total Preventive Maintenance, and Human Resource
Management. On the basis of these works we have tried to classify the lean production models on the basis of technical elements & human elements.

Here literature review is carried out in the direction to understand the attributes of Lean manufacturing. After the introduction of lean manufacturing/production there is a change in production system paradigm that can be compared to the introduction of mass production implemented by Henry Ford. The paradigm of lean production calls for integration of human & technological practices, parallel to the human centered approach to the design and implementation of advanced manufacturing systems (Karwowski & Salvendy, 1994: Karwowski et al., 1994; Karwowski, Warnecke, Hueser, & Salvendy, 1997).

2.2.1 Evolution of “Lean Concept”:

Lean is the westernization of a Japanese concept that has carried several names. It has variously been known as the Toyota Production System, JIT(Just in Time), Pull manufacturing, TQM(Total Quality Management), and by various other names. Each of these names incorporates some aspects of lean, and vice versa. What we know as “Lean” today is not really any of these any more. Three decade ago when the lean production models was proposed by Womack et al.(1990), Shingo (1989) and Krafcik (1988) it was viewed as a replacement alternative to traditional manufacturing. Katayama and Bennett (1996) declare that today it is arguably the paradigm for operations. What we call lean today should not be viewed in the narrow sense as merely a set of tools, techniques and practices, but rather as a holistic approach that transcends the boundaries of the shop floor thus affecting apart from the production itself almost to all the operational aspects, e.g design, development, quality, maintenance etc., as well as the entire organisation and management of the company and now a step ahead & moved even on the customer choice of consumption also. Lean has the point of attraction for so many years between researchers & practitioners. So many researchers have tried to define lean concept (e.g., Lewis, 2000; Hines et al., 2004; Shah & Ward 2007). Bhasin & Burcher(2006) viewed lean as a philosophy & as a long term journey. The purpose of the paper is to follow the evolution of the philosophy, which dates back to the introduction of the Toyota Production system (TPS) and extends to its current state in the form of lean enterprise to lean consumption.
2.2.2 Origins of lean manufacturing

The objective of this section tries to find out the origins of Lean manufacturing & how this concept has developed & its association from Toyota Production System & Just in Time philosophy.

2.2.3 Toyota Production System

During and after the World War II companies were facing fierce competition imposed by mass production systems of American companies. The companies of Japan were especially facing this problem because of lack of natural resources, which makes it necessary for them to import vast amounts of raw materials from other parts of the world. Thus Japanese companies were under tremendous pressure & disadvantageous condition in terms of cost of raw materials as compared to their counterparts companies of American & European. This forced them to think somewhat different from the rest of the world if indeed they want to sustain in this fierce competition. The only solution that Japanese industries find in order to overcome this problem is by putting their best efforts in order to produce better quality goods having higher added value and at even lower production cost as compared to other countries. This led The Toyota Motor Company (TMC) made a thorough study of the production system of the American automobile industry and in particular Ford now also known as (the Ford Production System –
FPS). In the 1930s, Toyota transferred Ford’s practices to its assembly lines; however, KirichoToyota’s goal was cost reduction without economy of scale. Toyota could not afford huge capital investments, so mass-production practices were adapted to Toyota’s capabilities. Taiichi Ohno, an assembly-shop manager, brought additional elements from his experience with the textile industry. Setup time reduction, workstation layout, and reduction in inventories were gradually tested on Toyota’s assembly line. The solution & changes offered by Toyota after testing on its own assembly line led to a complete reconstruction of the company and soon gave way to the introduction of an alternative & unique production system referred to as the TPS (Ohno, 1988), which aimed at directly attacking any form of waste in the production process. As soon as the success of this system was proved to the global manufacturing industry, a great number of companies worldwide adopted this system.

2.2.4 The lean manufacturing/production philosophy:

The popularity of the TPS with its unique features system attract more & more worldwide companies to implemented JIT system, & this led to development of a new dynamic system (Fujimoto, 2000) by the name of Lean manufacturing or lean production. Cost reduction was achieved by using fewer resources to compensate for the lack of growth. This third wave of production system change of research was encountered in the early 1980s. This time, the focal point of the research was “Lean Manufacturing”. LM is regarded not merely as a set of tools or guidelines but is considered as a manufacturing philosophy that if adopted and carefully implemented can undoubtedly brings unmatching global manufacturing excellence. This is one point where both researchers and industry people those who are practicing LM philosophy agree. Bhasin & Burcher(2006) considered lean as a philosophy which should be viewed as along term journey. Lean is a term coined by Krafcik (1988) at that time leading researcher in the International Motor Vehicle Program (IMVP) conducted at the Massachusetts Institute of Technology (MIT). The outcome of this project that it identify significant performance gap between western & Japanese automotive industry. In his landmark paper, Krafcik introduced the term Lean as compared to mass production it uses less of everything—half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products. In the famous book The Machine that Changed the World (Womack et al., 1990), offer perhaps the most solid proof that the relationship that exists between leanness
and the Toyota production system. The authors acknowledge that the Toyota Motor Company should be given the credit of initiating the Toyota Production System and the famous JIT philosophy and clarified that Lean is nothing but the outcome of the IMVP programme conducted in five years & has no such intention to present Lean Manufacturing system superior than TPS or LM has been developed to compete with TPS but rather Lean manufacturing or Lean production is nothing but the westernised version of Toyota Production System, & has been derived from TPS with some refinements and modifications. To support the view that Lean manufacturing is similar to TPS or JIT philosophy & nothing but refined & advanced version of the later is through literature published in the 1990’s. From the literature published during this time on Lean(Feld 2001; Hampson, 1999; Standard & Davis, 1999; Liker, 1998; Steudel & Desruelle 1992; Womack et al, 1990) & JIT(Monden, 1998; Bicheno, 1994; Harrison, 1992; JMA, 1989; Shingo, 1989; Ohno, 1988) it can be easily concluded that both the systems has different tools & techniques, & at some places they are overlapping also but there aims are similar when implemented is to reduce the time from customer order to delivery by eliminating sources of waste in the production flow.


- over production;
- waiting;
- transportation;
- inappropriate processing;
- inventory;
- unnecessary motions; and
- defects.

These are also known as the seven deadly wastes or sins Sutherland & Bennett (2008).

Katayama & Bennett(1996) defined the important aspect of this system as shown in figure that it requires fewer resources as inputs for manufacturing system(less material, fewer parts, shorter production operations, less unproductive time needed for set-ups, etc.) & at the side there is a higher pressure for for producing higher output(better quality, higher technical
specifications, greater product variety, etc.). The output thus results in greater satisfaction to the customer & provides the lean company an opportunity to grab a large market share & helps in long run for the company.

![Diagram](image_url)

**Figure 2.2:** Lean production system (Katayama & Bennett, 1996)

### 2.2.5 Lean Enterprise

The initial acceptance of lean model was considered fit only for manufacturing organization. But as the popularity of this system increases & it has proved itself its tools & techniques were applied to the entire enterprise level. The term enterprise here refers to every element in the organization starting from the suppliers to the customers i.e., it includes every member in the supply chain. A lean enterprise “is a business organization that delivers value to its stakeholders, with little or no superfluous consumption of resources (materials, human, capital, time, physical plant equipment, information, energy)” (Helling, 2001; MIT, 2000; Richards, 1999). Womack et. al (1990) was the first to used the term “Lean Enterprise” and describe it as the extension of the lean manufacturing approach to outside the boundaries of the organization. The lean enterprise concept basically consists of five fundamental principles of value, value stream, flow, pull and perfection as discussed by Womack & Jones (1996). Womack’s publication addressed each of these principles separately in their book “Lean thinking”. These lean principles are nothing but a problem solving approach to eliminate waste & can be used in any industry. The principles are

- **Value:** Value is something that the ultimate customer can determine & can except a combinations of goods & services. If there is value that means no waste has been created, & this determines the first principle.

- **Value stream:** Value stream is the path the product follows from the raw materials to the finished product or in other words assessing the actions of converting the raw material to finished product that are required to deliver the product as specified by the customer.. It involves three business processes:
problem solving (from design to product launch), information management (from order booking to delivery) and physical transformation (conversion of raw material to finished good). Once value stream is completed it will show steps that are immediately removable. This is an industry wide study rather than company-wide and therefore should involve the assessment of the relationship with the suppliers of goods & services.

- **Flow**: It is the interactions between various stages of value stream. The basic concept of flow is to change the perception of process focussed efficiency to product focussed efficiency in which how the interaction between various process play a major role along the supply chain

- **Pull**: Pull is considered as important element because of the induction of JIT. It is considered as the driver for enabling the value stream. Pull works only when there is a need from the customer side or pull makes the end customer responsible for initiating the production process & works in synchronization with the value stream for satisfying the customer.

- **Perfection**: It is nothing but the continuous search for identifying waste & due to which the synchronized flow of production doesn’t breaks. Lean production solves problems immediately and effectively so they will not recur as in case of traditional manufacturing.
Allen (2000), Nanni et al. (1995) and Oliver (1996) insist that there is no right hand thumb rule to explain each step of the lean process and exactly how to apply the tools within an organization. It varies and changes as per requirement of the organization or from process to process. Lathin (2001), Hall (1995) and Lathin and Mitchell (2001a, b, p. 2), insist that quality improvements are only possible if companies implement comprehensive change management programs addressing “both the organizational and technological aspects of quality management” i.e., within the entire enterprise. Bicheno (1999), argues lean needs to apply to every aspect of the value chain so as to keep the system efficient. Karlson and Ahlstrom (1996), insist lean ranges from an organisation’s product development to its distributional logistics:
The work by Karlson and Ahlstrom (1996) tries to find out the important principles contained within lean production. The determinants that were evolved were able to reflect changes in an effort to become lean. Lean principles are applied to the military, to construction, to service industry. The principles of Lean are universal & have been applied successfully everywhere. Here are few examples from different industries how the lean principles can be applied. Swank (2003) has defined how lean principles can be applied to a full-service life insurance and annuities company with $31 billion in assets & approximately 3700 employees improve operations & increases revenue. Czabke, Hansen & Doolen (2008) describes how by applying lean principles U.S & German secondary wood product manufacturers be more

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**Figure 2.4:** Lean production Source: Karlson and Ahlstrom (1996)
profitable. Hook & Stehn (2008) examined the applicability of lean principles & practices to industrialized housing in Sweden taking the production culture into considerations. Staats & Upton (2009) use the lean principles in software services & find that lean projects have better schedule & effort performance than non-lean projects. Grant (2005) shows how UK aerospace industry via the LAI has adopted similar principles, and in doing so has established a lean enterprise framework for quantifying performance across the entire supply chain.

**2.2.6 Lean Consumption**

Womack & Jones (2005) lean consumption doesn’t mean that consumers are buying less or starts consuming less or about reducing the amount customers buy or the business they bring. Rather, it's about providing the full value that consumer’s desire from their goods and services, with the greatest efficiency and least pain. Womack et al. (2005) states that for consumption the decision about purchasing a specific product can’t be taken in isolation, but as a continuing process linking many goods & services to solve consumer problems. When a customer wants to buy a product he does so many difficult & tedious job of searching catalogues & on internet, consulting with friends & well-wishers or those who are using the product, finding the nearest place from where they can get it, upgrading themselves & finally going for the purchase. For manufacturers or sellers (whether employees, managers or sellers) to achieve lean consumption processes basically requires how well they can linked all the business activities, especially across firms & how well they provide information or attract customers so as to meet customers requirement without much effort, time & resources. This is not a easy task because it requires tight integration & streamlining of various processes & channel members. For achieving lean consumption the major shift that is required is the way the retailers, service providers, manufacturers & suppliers think about the relationship between provision & consumption & the role that the customers play in the processes. Customers & providers must start work in a collaborative way to minimize total cost & wasted time to create new value.

The question that arise at this point of time that when everything is moving as per demand of customer or called the pull process why we are talking about lean consumption now. The answer to this question is that with the way globalization has done & the whole world is like a village & as a result of which the regulated economy is contracting & consumers have more choices at competitive prices and to support this the companies are also customizing their products to the minutes of the customer demand. With the support of information technology
the time between consumption & production has been blurred. Consumers are doing a big chunk of job free of cost for the companies by doing entering the data into web based order forms & by tracking the progress of their orders. In order to meet this changing demand Womack et al.(2005) defined six simple principles underlying lean consumption:

- Try to solve all the customers’ problem regarding goods & service which includes the search for obtaining, installing, integrating, maintaining and dispose of them over an extended period.
- Don’t waste the customers time
- Provide exactly what the customers wants
- Provide what exactly customer want & where it’s wanted
- Provide what, where exactly customer want & when it’s wanted
- Continuously tries to work together to find solutions to reduce the customers time & hassle

The lean consumption can be achieved somewhat through postponement strategy for example a two wheeler automobile manufacturer has launched 99 variants colour of its product, now for a automobile dealer to handle a stock of this much variant is very difficult & almost impossible because it requires lot of size & huge investment. So company has decided that only some parts of the two-wheeler would be coloured & the rest part will be based on modular manufacturing. The local dealer has tie-up with the nearest body paint shop so when a customer is demanding for an unusual colour vehicle model that part can be sent to paint shop & the painted part get assembled to the vehicle & the two-wheeler can be delivered to the customer within prescribed time period. This can only be possible when all the channel members are working for the provision & consumption.

Consumers also play a very vital role in lean consumption, the consumption problem of consumers will be solved completely, getting just what they want, when they want, where they want, and at an attractive price from a small number of providers, without not wasting time, hassle free work and with no unpaid work and this can be possible it they work in coordination with the other member of the supply chain. The biggest challenge lies with retailers, service providers, manufacturer and suppliers that are not looking at total cost from the standpoint of the consumer & seeing only from there own convenience & profitability but the real profit lies
when they work for the real consumers who is ultimately going to consume the product & the biggest challenge is that they are even less accustomed of working with customers.

2.3 History of Lean Production:

Just-in-time had begun at Toyota Production Company in order to fight a genuine corporate crisis in 1950’s. After World War II whole world was affected by a massive shortages of material, financial, and human resources. The condition was worst in Japan. These conditions gave rise to "JIT" production system concept, a branch of Toyota Production System. “Taiichi Ohno” was heading to developing a system that would enhance productivity at Toyota. Ohno drew upon some ideas from the west and particularly from Ford's moving assembly line of continuously flowing material formed the basis for the Toyota production system. After some experimentation, Toyota production system was developed and refined between 1945 and 1970, and is still growing today all over the world. The basic underlying idea of this system is to minimize the consumption of resources that add no value to a product.

2.3.1 Concept of Lean Production:

Abdullah Fawaz (2003) said that the revolution in the manufacturing sector has created great challenges for an industry. The customer driven and highly competitive market has rendered the out-fashioned managerial style an inadequate tool to survive with these challenges. These factors present a big challenge to companies to seek new tools and techniques to continue moving up the ladder in a global, competitive, growing market while some companies continue to grow based on economic reliability, other companies struggle because of their lack of understanding of the changing customer mind sets and cost practices. To escape of this situation and to become more profitable, many manufacturers have started to adopt Just-in-Time manufacturing principles to uplift the performance of their firms. The basic ideas behind the Lean production system, which have been practiced for many years in Japan, are waste elimination, cost reduction, and employee empowerment. The Japanese philosophy of doing business is entirely different than the philosophy that has been long practices in the other country. The traditional belief in the west had been that the only way to make profit is to add it to the manufacturing cost in order to come up with a desired selling price (Sales price = Manufacturing cost + Profit) (Ohno, 1997) on the other hand; Japanese approach believes that
customers are the originator of the selling price. The more quality one add into the product and more service one offers, the more price that customers will pay. The difference between the costs of this price is what determines the profit \( \text{Profit} = \text{Sales price} - \text{Manufacturing cost} \) \([\text{Monden (1998), Ohno (1997)}]\). The Lean manufacturing discipline is to work in every aspect of the value stream by removing waste in order to getting cost down, generate profit, acquire more sales, and sustain in this growing competitive global market.\([\text{Abdullah Fawaz (2003)}]\) defines value stream as "the specific activities within a supply chain required to design, order and provide a specific product or value". The term "JIT" which is a tool of Lean is described as \([\text{Womack et al. (1990)}]\) a system that utilizes less, in terms of all inputs, to create the same outputs as those created by a traditional mass production system, while contributing increased varieties and value for the end customer. This business/manufacturing philosophy known by different names like: Agile manufacturing, lean manufacturing, synchronous manufacturing, world-class manufacturing, Toyota production system, zero inventory production system, stock-less production system, and continuous manufacturing system \([\text{Abdullah Fawaz 2003, Cheng.T.C.E (1996)}]\). "Lean" focuses on eliminating or reducing Muda ("Muda", the Japanese word for waste) and don't maximizing or fully utilizing resources that add value to the customer's perspective. From the customer's point of view, value is perception of the customer about the product or the service for which he pays willingly. So the abolition of waste is the basic principle of JIT production system which also referred as “Lean production”

### 2.3.2 Seven Types of Wastes:

1. **Over production**- Producing too much and too soon due to poor flow of information or goods and excess inventory.

2. **Defects**- Continuous error in paper work, problems in product quality and poor delivery performance are the major defects.

3. **Unnecessary Inventory**- Over storage and delay of information or product causing in excessive cost and poor customer service

4. **Inappropriate Processing**- Application of wrong tool, procedures or systems in the operation
5. **Excessive Transportation**- Excessive movement of goods, information and people causing in wastage of time, cost and money

6. **Waiting**- Idle people, machine, information or goods resulting in poor flow and long lead time

7. **Motion**- Poor workplace organization, resulting in poor ergonomics, e.g. excessive bending or stretching and frequently lost items

**2.4 Goals of Lean Production System:**

Lean Manufacturing tries to smooth and ease the flow of materials and information from the suppliers to the customers, thereby increasing the speed of the manufacturing process by reducing waste non value adding activities. The objective of Lean is to change the manufacturing system step by step. Lean manufacturing can help organization remains competitive by offering consumers higher quality of products continuously in best prices than their competitors, it is very important to ensure survival in the market place. Lean objectives are same of all organizations but every organization has its own style to fulfill these objectives. According to [Goddard (1986) and Peschke R.E. (2000)], Lean production system therefore seeks to achieve the following goals-

1. **Zero Defects**- in manufacturing, usually had people thought that zero defects producing were not illogical and not necessary. Illogical because of the fact that people thought that at some level of production it would be not possible to produce products without defects and not necessary because though there were defects, the product did influence customers’ expectation. With the aim of JIT there will be no longer any wastage and delay due to defect and therefore all products will meet customer expectations more effectively. This is a part of Total Quality Management (TQM).

2. **Zero Set-up Time**- Reducing the set up-times leads to a more definite production. It leads to no hindrance between production processes while changing dais. No set-up time also leads to a shorter production time/production cycle, fewer inventories and more output.

3. **Zero Inventories**- Inventories includes raw material, work-in-progress, semi-finished goods and finished goods and subassemblies. Goal of JIT is production of the standard product without having any type of inventory level in the stock.
4. **Zero Handling**- Zero handling in JIT means eliminating all non-value adding activities. Arrangement of all the facilities (equipment and materials) nearest to the production line so that there will be no need of handling which can save time and efforts in the operations.

5. **Zero lead-time**- Zero lead time is a result of the ordering in small lots and continuous ordering which increases the flexibility of the system. The JIT philosophy recognizes that in some markets it is impossible to have zero leadtimes, but it makes clear that when a firm focuses on reducing lead-times, this firm can produce more flexible than other manufacturers in the same market.

6. **Lot Size of one**- A lot size of one makes it possible to adapt when demand is changing. Producing in small lots protect the manufacturer from demand uncertainty. The use of Kanban systems ensure limited and continuous supply of the material so that the product produce and delivered to the market before any demand change.

2.5 Lean Production System Guiding Principles

2.5.1 **Pull production system:**

JIT philosophy employs what is known as a “pull system” customer demand as contrast of a “push system”, which starts from the customer’s order, the first signal to production. As the result, the product sets pulled out of the assembly process. The final assembly line goes to the preceding process and pulls the necessary parts in the necessary quantity at the necessary time; [*Monden Y. (1998)*]. The process goes on as each process pulls the needed parts from the preceding process further upstream. The whole process is synchronized through the use of a kanban system. Shipments under JIT are in small, continuous lots. A kanban is used to manage these shipments effectively. Following figure shows the operation of pull production system under JIT conditions, [*Holmback Jessica T. (2003)*].
2.5.2 Kanban Production System:

Kanban is an information system that is used to control the quantity of parts to be produced in every process. The most common forms of Kanbans are the withdrawal kanban, which specify the quantity that the succeeding process should pull from the preceding process. The production kanban specifies the quantity to be produced by the proceeding process. A supplier kanban is another type of kanban that is used between the supplier and the manufacturer under JIT. In order to attain JIT delivery, suppliers have to revise from the traditional run sizes to smaller lot sizes; [(Monden Y. (1998))]

By utilizing a kanban system under JIT, smaller lot sizes and huge inventory reductions can be achieved. Under this production system raw material, subassemblies and finished product inventory are kept to a minimum and the JIT production principles are followed to eliminate inventory as a source of waste. Following figure given by [(Monden Y. (1998))] shows the Kanban system:
Key: The solid line represents movement of parts, the broken lines represent the circulation of kanban, the circle represents the machines and the triangle represents the buffers. Another type of waste that is eliminated under JIT production is overproduction since every process is producing at a pace no higher than that of the subsequent process requirements, the need to produce more than what is diminished.

2.5.3 Kaizen (Continuous Improvement):

JIT improves the manufacturing system progressively rather than radically. This gradual continuous improvement is defined by APICS Dictionary as “one less at a time”; a process of gradually reducing the lot size of the number of items in the manufacturing pipeline to expose, arrange, and remove waste. The Japanese refer to continuous improvement as kaizen. According to them, kaizen means to try persistently to increase quality, efficiency and effectiveness in all areas of production. The continuous improvement approach is explained by the Shewhart-Deming plan-do-check or study action (PDCA or PDSA) cycle that appears in the following figure. The PDCA cycle involves using a variety of statistical tools and techniques and is an everlasting activity for companies that hold the continuous improvement methodology. Some of the statistical tools used in the continuous improvement cycle include: Pareto diagrams, Fishbone or cause and effect diagrams, Histograms, charts, Control charts and related techniques.
Pareto diagrams - Show the causes of problems in bar chart format. The idea is to graphically display opportunities for potential improvement.

Fishbone diagrams - Show a sketch of the relationships that may contribute to a particular problem.

Histograms - Show the distribution of a performance measurement such as the number of shortages, or the number of defects, over a period of time.

Control charts and scatters diagrams - They are perhaps the most important statistical tools available to support in the PDCA continuous improvement effort, and they were given considerable attention. Control charts are used to determine when a process is stable and whether or not it is in control. Control charts are also used in the check step to reveal the success of the plan and do steps in improving the mean outcome or in reducing the variability of the process. Scatter diagrams, the related regression and correlation techniques are powerful tools for identifying cause and effect relationships. [Badiru B. (1993)]

2.5.4 Total Quality Control (TQC):
TQC, also known as Total Quality Management (TQM), is a management tool for improving total performance of the organization. TQC means organized Kaizen activities involving everyone in a company from managers to the workers in a totally systematic and integrated effort toward improving performance at every function level. It is to lead to increased customer satisfaction through satisfying such corporate cross functional goals as quality, cost, scheduling, manpower development, and new product development [Badiru B. (1993); Groover P. Mikel(2001)]. In Japan, TQC activities are not limited to quality control only. Elaborate system of Kaizen strategies has been developed as management tools within the TQC approach. TQC in Kaizen is a movement aimed at improvement of managerial performance at all levels. According to the Japan Industrial Standards, "implementing quality control effectively requires the cooperation of all people in the company, including top management, managers, supervisors, and workers in all areas of corporate activities such as market research and development, product planning, design, preparation for production, purchasing, vendor management, manufacturing, inspection, sales and after sale services, as well as financial control, personnel administration, and training & education. Quality control carried out in this manner is called company-wide quality control or total quality control (TQC)"[Nicholas, John M. (1998)]. JIT requires high quality in every aspect of production. There are countless points to emphasize when considering TQC [Groover P. Mikel(2001)]; some of the stronger areas to concentrate on are as follows:

- Seeking long-term commitment to quality efforts will ensure that efforts will be maintained throughout the life of the company.
- Quality must be a higher priority than cost.
- Minimizing Waste in production consists of more than minimizing losses of time and resource.
- Eliminate Quality Inspectors, Make Quality everyone’s responsibility, and doing the job right the first time.
- “Total Quality Control” is one of the fundamental goals in JIT manufacturing.
- Quality is an integral part of a JIT program.

2.5.5 Inventory Management:

The main stress in JIT manufacturing is the goal of Zero Inventory; to achieve this goal the safety stock must be eliminated. A reduction in WIP will reduce the number of defects in the
happening of a problem. JIT is not an inventory control system; it is a philosophy for continuous improvement of quality that puts emphasis on prevention rather than correction. Reduction of Inventory will also uncover more space in the factory [Tersine, Richard J. (1983)]. The correlation of reducing inventory and overall performance is dependable. Inventory hides problems in a process, if you reduce it, then problems in the system becomes visible. Inventory also blocks the capital of the organization and affects the company objectives. Excess inventory create the problem of regularly tracking and maintaining it which consume human efforts, time, cost and space also.

2.5.6 Total Productive Maintenance:

Machine breakdown is one of the most important issues that worry the people on the shop floor. The consistency of the equipment on the shop floor is very important since if one machine breaks down the entire production line could go down. Total productive maintenance is a tool which justifies the sudden breakdown of the machines and equipment. In almost any lean environment setting a total productive maintenance program is very important [Abdullah Fawaz (2003); Alan Harrison (1992)].

There are three main components of a total productive maintenance program-

- Preventive maintenance
- Corrective maintenance
- Maintenance prevention

*Preventive maintenance* has to do with prescheduled maintenance on all equipment rather than random checkups. Workers have to perform require equipment maintenance to detect any irregularities as they occur. By following such practices sudden machines breakdowns can be prevented, which leads to improvement in the throughput of each machine.

*Corrective maintenance* deals with decisions such as whether to fix or buy new equipment and when to do that. If a machine is always down and its components are always breaking down then it is better to replace those parts with newer ones. As a result the machine will last longer and its up time will be higher.
Maintenance prevention has to do with buying the right machine. If a machine is hard to maintain (e.g., hard to lubricate or bolts are hard to tighten) then workers will be hesitant to maintain the machine on a regular basis, which will result in a huge amount of lost money invested in that machine [Abdullah Fawaz (2003)].

2.5.7 Total Employee Involvement:

A successful JIT environment should have the cooperation and involvement of everyone in the organization. People are managers when they have a hand in planning their job activities and measuring the results of what they have done. The total employee involvement philosophy includes [Plenert Gerhard J. (1993)]-

Teaming: This involves placing employees into teams and making their brains work as well as their hands. Employees are asked to be part of a team, to discuss problems, and to search for solutions. These teams are formed across all disciplines so that engineers, shop floor employees and accountants all working on teams together and expert solution can be drag out.

Empowerment vs. Top-down management: Empowerment involves the delegation of decision authority to the employees. If the employee team makes a decision, they have the authority to implement the decision. Decisions flow upward as opposed to the traditional top down management.

Shorter organizational charts: The communication linkage between top management and the line worker needs to be shortened with increasing the span of control for each manager, and the current number of middle management levels is no longer required.

Profit sharing: The motivation behind the teaming concepts is profit sharing. Employees benefit from the involvements they generate by sharing in the profit of the organization.

Job security: A fundamental principle behind proper motivation and improvements in quality is that employees need to get out of their mental block of job uncertainty. If employees are afraid to make suggestions because they may work themselves out of a job, or if they are afraid to speak up because they may offend some one and get fired, many of the improvements, which could be made, will never be made. To avoid this problem, employees are guaranteed their job for the life of the organization.
**Cross functional training and Job rotation:** Employees are rotated out of their job for a particular time and trained into a new job. They are not only trained on how to do the job, but they are also trained about the quality and maintenance issues that go along with the job. The principle here is that an employee with a well-rounded background about how the company operates will be valuable to the company in making improvements.

**2.5.8 Production Smoothing (Heijunka):**

In a JIT manufacturing system it is important to move to a higher degree of process control in order to reduce waste. Heijunka the Japanese word for production smoothing is used where the manufacturers try to keep the production level as constant as possible daily [Abdullah Fawaz (2003); Chase B. Richard (1989); Womack, J.P (1990)]. Heijunka is a concept adapted by Toyota production system, where in order to decrease production cost it was necessary to build no more cars and parts than the number that could be sold. To accomplish this, the production schedule should be smooth so as to effectively produce the right quantity of parts and efficiently utilize manpower. If the production level is not constant this leads to waste (such as work in-process inventory or idle resources) at the work place.

**2.5.9 Poka-Yoke (Error proofing):**

Poka-yoke is a Japanese word, which has come into regular use within the lean manufacturing concepts. It is the use of simple mechanisms that stop line mistakes being made by manufacturing associates. Most often these Poka-yoke’s or fail-safe devises are very convenient and often inexpensive visual prompts that prevents the defect in the product occurring. Either the operator is alerted that an error is about to be made, or the device actually prevent the mistakes from being held. The important point of these types of mechanism is that 100% of the parts are checked without the need for concentration from the operator. The term “Poka Yoke” was popularized by “Shigoe Shingo” through his book “zero quality control”: source inspection and the Poka-yoke system”. Shingo points out that mistakes will always be made, but if Poka-Yoke’s are implemented then mistakes can be prevented from becoming defects (mistakes that reach the customer). Poka-yoke’s are an effective and relatively inexpensive way of reducing manufacturing defects and therefore the quality costs, however the concentration should be on
why to commit a mistake and need of Poka-Yoke. A long term aim might be to eliminate the source of problem not just prevent it from occurring.

2.5.10 Performance Measurement:

For whatever we seek to improve or waste we seek to eliminate, measurement is necessary to know exactly where we are, where we have been, and where we are going [Nicholas, John M. (1998)]. Lean organizations employ the measurements in ways unlike many traditional measurements systems. One key to Lean success stems from the feedback mechanisms developed including the 35 measures of improvement [M. Scott Myres (1998)].

<p>| 1. Quality | usually measured in terms of percent yield, defects, scrap or rework; sometimes in terms of customer returns or complaints. |
| 2. WIP | work in process inventory from getting through final assembly. |
| 3. Manufacturing flexibility | Number of different models or products producible per unit of time. |
| 4. Turns | Number of times inventory turns per year. |
| 5. Lead (or through put) time | time between order entry or start of production and delivery; sometimes expressed as cycle time. |
| 6. Value added (or production) time | amount of time material or product is being subjected to change. |
| 7. Throughput ratio | ratio of value added time to throughput time. |
| 8. Set up (Changeover) time | amount of time from last good piece to first good piece. |
| 9. RM &amp; FG inventory | amount of raw material or finished goods in stocks. |
| 10. Floor space | square feet of floor space to accommodate operations. |
| 11. Flow distance | total material travel distance through operations. |
| 12. Cycle time | time to complete a unit, subassembly, total product, batch, or customer order; sometimes order turnaround time or customer lead time. |
| 13. Transit time | time required moving inventory from one operation to another. |</p>
<table>
<thead>
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<tr>
<td>14. <strong>Queue time</strong></td>
<td>time material waits to be worked on.</td>
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<tr>
<td>15. <strong>Down time</strong></td>
<td>amount or percent of unplanned and/or scheduled time equipment down for repair or maintenance.</td>
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<tr>
<td>16. <strong>Inspection delay</strong></td>
<td>any checking time, especially time required to subject product to simulated aging and stress conditions.</td>
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<td>17. <strong>On-time performance</strong></td>
<td>everything done when said.</td>
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<tr>
<td>18. <strong>Suppliers</strong></td>
<td>number of suppliers; or certified suppliers who furnish inventory without incoming inspection.</td>
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<tr>
<td>19. <strong>Forklifts</strong></td>
<td>number of or amounts of time forklifts are in operation.</td>
</tr>
<tr>
<td>20. <strong>Employee versatility</strong></td>
<td>ability to actually change tasks on short notice.</td>
</tr>
<tr>
<td>21. <strong>Suggestions</strong></td>
<td>number of accepted suggestions generated by employees.</td>
</tr>
<tr>
<td>22. <strong>Team work</strong></td>
<td>organized and spontaneous cooperative effort.</td>
</tr>
<tr>
<td>23. <strong>Motivation</strong></td>
<td>enthusiasm and attentiveness with which people respond to challenges and responsibility.</td>
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<tr>
<td>24. <strong>Turn over</strong></td>
<td>rate at which people are replaced.</td>
</tr>
<tr>
<td>25. <strong>Absenteeism (or tardiness)</strong></td>
<td>– time away job when needed.</td>
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<tr>
<td>26. <strong>Morale</strong></td>
<td>usually expressed in terms of percent favorable responses to pivotal item in attitude survey.</td>
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<tr>
<td>27. <strong>Real work</strong></td>
<td>percent time worked without instructions by complexities.</td>
</tr>
<tr>
<td>28. <strong>Housekeeping</strong></td>
<td>work area clean, uncluttered, and orderly.</td>
</tr>
<tr>
<td>29. <strong>Labor costs</strong></td>
<td>many spent for direct/indirect labor.</td>
</tr>
<tr>
<td>30. <strong>Margins</strong></td>
<td>sales price minus production costs.</td>
</tr>
<tr>
<td>31. <strong>Capital expensive</strong></td>
<td>money spent for capital equipment.</td>
</tr>
<tr>
<td>32. <strong>Operating expense</strong></td>
<td>cost of converting inventory to sales.</td>
</tr>
<tr>
<td>33. <strong>Cash flow</strong></td>
<td>timely receipt of money generated through sales.</td>
</tr>
<tr>
<td>34. <strong>ROI</strong></td>
<td>return on investment, money received (before taxes) as percent of money spent.</td>
</tr>
<tr>
<td>35. <strong>Profit</strong></td>
<td>absolute bottom line net return after distribution of income to employees, shareholders and government.</td>
</tr>
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</table>

Measurement establishes priorities for workers, departments, and the organization. In JIT organizations, the standardized measures listed above are being used by people at all levels and
in all functions as bridges between factory performance and bottom-line measures. While the performance measures given above are not a universally applicable list, it is illustrative of criteria each organization can develop with the help of its members. The responsibility of the each individual in performance measurement is very important to be decided.

**2.5.11 Lead time and Cycle time reduction:**

Lead times reduction in a JIT environment will enable a company to respond quickly to customer needs simply by reducing the time required to make products and have them available to customers. In manufacturing, lead time was measured starting from design until deliver the products or services to the customers. Thus, the lead time consists of the following time elements: Product Development (Design) leads time, Sourcing (purchasing) lead time, Manufacturing (production) lead time, Order processing lead time, Distributions lead time, Other (e.g. decision making, coordination) lead time, clearly, production lead time is only a small portion of the whole lead time, but it is the only component which is controllable by production function. Manufacturing lead time consists of the following five elements [Cheng, T.C.E., S. Podolsky (1996)]:

1. **Waiting time**: - The time subsequent to the completion of operations.

2. **Moving time**: - The duration required moving between machine operations.

3. **Queuing time**: - The time period to the commencement of operations. In many organizations, queue time is responsible for approximately 80-90% of the total manufacturing lead time.

4. **Machine set-up times**: - The amount of time required completing machine changeovers and set-ups.

5. **Running time**: - The time required for work in-process parts to complete a machine operation.

Efficient management of lead time reduction can be achieved through the use of a ‘closed-loop’ system.
The closed loop system is capable of adjusting to changes and providing returns between supply and demand, customers, plants and suppliers. Reducing the aggregate lead-time or the sum of lead times for purchasing materials, manufacturing operations and product assembly allows a company to reduce planning horizon for production. Reducing the planning horizon allows the company to increase the accuracy of its demand forecasting. Reducing the inaccuracies of demand forecasting diminishes the amount of buffer inventory that would otherwise be required.

2.5.12 Setup time reduction:

Setup time is time spent in preparation to do a job. In manufacturing, set-up time is the intervened time between when the last unit of one lot is produced and when the first good unit of the next lot is produced. Set up or changeover reduction has been an important element of lean thinking for a number of years.

Set-up time refers to the time taken to physically make the change to the line in order to run the new product, run-up time is the time taken to make adjustments to the line in order to produce products of the specified quality at the specified production speed. Set-up reduction can cause lot-size reduction, reduction of inventory, reduction of the cost of setup labor, increase the capacity on bottleneck equipment, eliminate the set up scrap, and reduce the potential quality problems and obsolescence [Chao-Hsien Chu]. There are a number of potential advantages to
reducing the time taken to changeover a production line, these include: increased efficiency, reduced stock requirement, increased capacity, reduced work in process, increased flexibility.

2.5.13 Set-up Reduction Methodology:

Probably the foremost authority on setup reduction is Shigeo Shingo. Shingo, over many years working as a consultant to Toyota and other Japanese Manufacturers, developed a methodology to analyze and reduce the change over time for dies on huge body molding presses. With the methodology, which he called SMED for single minute exchange of dies; Shingo was able to achieve astonishing improvement [Nicholas, John M. (1998)].

2.6 Overview of JIT Practice:

A number of researches have been conducted on the benefits and implementation of JIT in context of various industries in many countries. There are wide pros for an organization in adopting JIT practices like cost and wastage reduction in all the functions and quality improvement of the product and the processes, but another facet of the coin is still not in the light i.e. the challenges and the difficulties in the implementation of this revolutionary concept called JIT and the ideal system and procedures of the organization that support JIT to be implemented in a pace. The available literature in the area of challenges part shows partial work and has a wide scope for further study in the context of Indian industries.

Singhvi (1992): To what extent employee involvement plays role in JIT success. In spite of large investment “employee involvement” is a critical element for implementing JIT.

Garg, Vrat and Kanda (1994): To find out the essential of Efficient JIT environment. Trust, loyalty, responsibility, development, motivation, authority, long term relationship and respect for human are cultural requirement in JIT environment. Top management commitment and worker participation in decision making are required for these changes.

Garg, Deshmukh and Kaul (1996): To analyses the attribute of JIT purchasing, supplier evaluation criteria. High quality, mutual trust, cooperative relationship, on time delivery, stable production schedule, long term contract and continuous improvement are the major and important factors.
Deshmukh (1996): To review state of art of JIT and its possible ramifications in purchasing and manufacturing system. JIT as system perspective requires suppliers and manufacturing function must be in concert with design, planning and control. All the activities should be integrated from raw material to finished goods.

Mahadvan (1997): To find out the factors constitute the basic requirement for successful JIT implement in any firm. TQM and vendor development efforts must precede the launch of major JIT programs along with other factors.

Dalci I.; Tanis V.N. (2001): To discuss the effects of Just-in-time production system from cost and management accounting perspective. JIT helps in significant cost saving by reducing inventory related costs, increase quality, reduce lead time and reducing manufacturing costs. These all savings are the results of Effective implementation of the system and team work to a predefined objective.

Vilpola and Tan (2003): To figure out the advantages and limitations in the implementation of JIT production system. JIT has a lot of pros like inventory reduction, lead time reduction, operational efficiency and minimized cost but on the other hand it has limitations like Cultural differences in the organization, traditional rigidness, relationship between management and employees, employee skills and compensation etc.

Vikas kumar, Garg and Mehta (2004): To examine the implementation of JIT based managerial philosophy in Indian industries. To gain full success of JIT Indian industries must be willing to modify their procedures and operations. Training of employees to create organizational culture, new procedures for dealing with suppliers, standardization, simplification, automation and reengineering of processes and procedures are required for JIT.

Radisic M. (2005): To evaluate the contribution of JIT in customer satisfaction. Besides JIT resource allocation, human factors and many other factors are there who contribute to the value chain of the organization and lead to consumer satisfaction.

Moreira and Alves (2008): To find out what extent JIT is being implemented by Portuguese firms and what are the difficulties in JIT implementation. Difficulty in
controlling the production, Poor inventory planning and no supplier participation are the main reasons for poor JIT implementation.

2.7 Lean Production Model:

In order to evaluate Lean manufacturing tools, researcher has carried out literature review to identify the variable of lean manufacturing on the basis of human & technical elements. The variables identified are presented in tabulated form as shown below

Andrea Furlan, Andrea Vinelli, Giorgia Dal Pont, (2011): This study examines the complementarily effects on operational performance of two of the main lean manufacturing bundles, just-in-time (JIT) and total quality management (TQM) & explores the role played by the human resource management (HRM) bundle

Todd A. Boyle, Maike Scherrer-Rathje, Ian Stuart, (2011): This study examines the role of management exposure to external information sources & helpful for organization to achieve lean goals by studying organizational & environmental factors

Ifechukwude K. Dibia and Spencer Onuh(2010): This study takes a holistic look at the Human Resource optimization and also emphasizes the elimination of waste in order to ensure optimum utilizationof all available resources in Lean Production Systems.

Jing & Xuejun (2009): This study addresses that for effective implementation of lean production requires adaptive organizational change, extends Leavitt's organizational change model, and compares mass production and lean production in five aspects, including organizational structure, task, people, technology, relationship between organizations.

Olivella, Cuatrecasas, and Gavilan, (2008): This study reveals clear connections between work organization practices and Lean production. Similarities are found between the different sources in terms of defining a set of policies and practices covering all the aspects of work organization.

Shah & Ward(2007): This study addresses the confusion and inconsistency associated with lean production by using a historical evolutionary perspective in tracing its main component like JIT, quality management, set up time reduction, small lot size, pull system, kanban, cellular manufacturing, continuous improvement, statistical process control, product design JIT delivery
by suppliers, workforce management, group problem solving training, cross functional team, employee involvement, customer involvement

**Arbós & Nadal (2006):** The study states that shop-floor work organization is a central aspect of analysing lean practices and supporting their implementation & is part of a project aimed at obtaining tools to help companies with the work-organization aspects of LP implementation. Lean shop-floor work can be defined through standardization and control; training and learning; participation and empowerment; teamwork; multi-skilling and adaptability; common values; and compensation and prizes.

**Bhasin & Burcher (2006):** The study states that a mix blend of factors are needed for lean success i.e., technical tools (continuous improvement/ kaizen, cellular manufacturing, kanban, single piece flow, 5s, TPM) & organizations culture needs (Learning environment, lean leadership, training, customer involvement).

**Treville & Antonakis (2006):** This study explain the theoretical relationship between job characteristics and motivational outcomes in lean production. Lean production job design may engender worker intrinsic motivation; however, there are likely to be substantial differences in intrinsic motivation under differing lean production configurations.

**Fullerton, McWatters, Fawson, (2003):** This study explains the linkage between financial performance (Return on sales, return on assets, cash flow margin) & JIT

**Parker, Shah & Ward, (2003):** Seeing organizational performance as resulting from the combination of both types of practices i.e., operational & human resource practices

**Nightingale and Mize (2002):** Study the effectiveness of the lean enterprise tools among the US & UK enterprise

**Stefano Biazzo, Roberto Panizzolo, (2000):** The study focuses more on working situation from the worker’s perspective & evaluates the change in work organization using just-in-time production, quality circles & empowerment, problem-solving groups.
Fullerton and McWatters (2000): This study demonstrates that implementing the quality, continuous improvement, and waste reduction practices enhance firm competitiveness. The research results demonstrate that implementing the quality, continuous improvement, and waste reduction practices embodied in the JIT philosophy can enhance firm competitiveness. JIT implementation improves performance through lower inventory levels, reduced quality costs, and greater customer responsiveness.

Lewis (2000): This study seeks to establish what impact lean manufacturing had on the overall competitive positions of adopter firms. Combining normative and critical theory (from lean production and resource-based view), lean production can underpin competitive advantage if the firm is able to appropriate the productivity savings it creates, similarly the ambiguity of lean production in practice means that the implementation process can create strategic resources to underpin sustainable competitive advantage.

Claycomb, Germain and Droge (1999): This study examines evidence of the performance implications of just-in-time (JIT) implementation. Examines total system JIT’s empirical relationships with a variety of performance outcomes. Total system JIT encompasses JIT purchasing, JIT production, and JIT selling. Total system JIT was found to be: inversely related to weeks of inventory (inclusive of inbound, in-process, and outbound); inversely related to the number of layers in various functional areas (e.g. marketing); and positively related to three different indicators of financial performance (ROI, profits, and ROS).

Shah & Ward (1999): This study examines the effects of three contextual factors & their effect on implementation of lean production system.

Jenner (1998): The framework emphasizes more on human elements like flexible units, communication expansion & direct authority of lean production than technical elements (requisite variety, external focus, amplification & bounded chaos).

Ohno (1998): Framework based on TPS (Autonomous control, kanban system, standard operations, production smoothening, information at the source, improvement activities, problem solving focus (5 Whys), teamwork) with emphasis more on human element.

James-Moore and Gibbons (1997): Study examines the effect of lean methods on low volume production by considering the variables like people utilization: housekeeping, flexibility: quick
set up times and product development time, waste elimination: high yield, low inventories, and low time through system, optimization: financial optimization, supplier partnership and effective R&D, people utilization: teamwork and empowerment flexibility: multi skilled workers

**Power & Sohal (1997):** There literature review concerning the human aspects of Just-in-time, cellular manufacturing and lean production. Eight categories were identified: corporate culture, organizational structure, use of team, human resource issues, employee involvement, education & training, workforce flexibility and the use of Kanbans.

**Rasch(1997):** Study examines the Lean production system consists of two subsystem viz supplier system(high involvement organizations)& core production system(built in quality system, just in time and enabling systems)

**McLachlin (1997):** The study considers the number of management initiative for the implementation of JIT manufacturing. The initiative for successful JIT quality & JIT flow are promotion of employee responsibility, provision of training, promotion of teamwork and demonstration of visible commitment.

**Karlsson and Ahlstrom(1996):** Study the lean principles like lean development: simultaneous engineering and black box engineering, lean Procurement: supplier hierarchies and larger subsystems from few suppliers, lean manufacturing: elimination of waste, vertical information systems and pull instead of push, lean distribution: lean buffers, lean manufacturing: continuous improvement, multifunctional teams, and decentralized responsibilities having a concern on work organization in manufacturing

**Oliver, Delbridge and Lowe (1996):** The study examines the lean production inside (teamwork, problem-solving and human resource practices)& outside(integrated material flows, active information exchange, joint cost reduction and shared destiny relations) the factory & its effect on performance

**Ledford, (1995):** Just-in-time is a system geared to making products in direct response to internal and external customer demand rather than building for stock that is a "pull" rather than a "push" system. Each stage in production is completed just in time to allow the next to be completed immediately following it, and the customer to be guaranteed just-in-time delivery
Macduffie (1995): Operational changes alone do not yield expected benefits without a “bundle” which includes structural, managerial and cultural changes.

Womack, Jones, & Roos, (1990): The notion of lean manufacturing, extends the operational practices to include supply-chain partnering

Crosby, (1989): Total quality management is based on the principle that quality control should be an integral part of the production process, and thus a primary responsibility of operators, rather than a separate policing and rectification function. Key features include continuous improvement to reduce waste, doing things right first time, and quantitative measurement to analyze deviations from target quality levels

Monden(1983): Framework based on TPS with more emphasis on technical element such as Autonomation, Just in Time & flexible workforce, creative thinking

2.8 HRM Practices and Firm Performance

A number of researchers examining the relationship between HRM and firm performance have taken a micro approach, investigating single HRM practices such as staffing, training, goal-setting, compensation, and so forth, and the effects of those practices on organizational level outcomes.Russell, Terborg and Powers (1985) examined the relationship between training, organizational support, and performance of organizations in a sample of sixty-two retail stores. Their study utilized both archival data information obtained from a company-developed attitude survey. The findings provided evidence that both training and organizational support was positively and significantly related to store performance.In a study conducted by Balkin and Gomez-Mejia (1987) on compensation, they found that incentive-based reward systems were more effective in growth stage and in high-tech companies. Jackson, Schuler and Rivero (1989) examined the variation in performance appraisal, compensation, and training and development programs within different strategic setting. Results obtained from survey responses for 267 firms showed firms utilizing an innovation strategy as a means of differentiation versus other firms were: a) less likely to use incentive compensation; b) more likely to offer employment security; c) likely to provide more total hours of training, and d) more likely to offer employees training related to both skills needed currently and skills needed in the future.Gerhart and Milkovich (1990) examined the effects of both contingent pay and base pay on firm performance. They also studied the determinants of pay mix in an effort to discern the extent to
which pay mix decisions vary after controlling for employees investments in human capital, personal characteristics, and job characteristics. They found support for variation in pay mix even after controlling for these factors. They also found significant relationships between pay mix and industry, firm size, and firm financial performance. Terpstra and Rozell (1993) also examined the effects of extensive staffing practices, with firm performance as their dependent variable. The staffing practices they investigated were (1) follow-up studies on recruitment sources, (2) validation studies on selection instruments, (3) structured/standardized interviews, (4) cognitive or mental ability tests and (5) biological information blanks or weighted application blanks. It was found that the extent of use of these staffing practices varied by industry and organizational size. Performance measures examined in the study were annual profit, profit growth, sales growth and overall performance. The results of the study demonstrated a positive and significant effect of extensive staffing practices on annual profit, profit growth and overall performance. Bartel (1994) also utilized training as an independent variable, and labor productivity as her dependent variable. She found that the implementation of formal employee training programs was positively and significantly related to labor productivity gains. The studies cited above provide examples of the growing interests in the effects of specific HRM practices on organizational outcomes. However, HRM policies and practices do not exist in organizations in isolation. Consequently, a growing body of work has turned toward examination of these systems of HRM practices in an effort to determine the true impact of HRM on organizational performance.

2.9 Performance Measure of Firm:

A number of researchers examining the relationship between world class system and superior firm performance. Here superior performance of the firm is defined as:

✓ Performance in context of Organization is a broad concept which has been used synonymously with productivity, efficiency, effectiveness, and more recently competitiveness (Cooke, 2000).

✓ The ultimate goal of an organization is to grow and make profits. This measure covers increase of market share, competitive position, and the capability of staying in its business (Digalwar and Sangwan, 2007).

The firm performance measure can be divided into two categories: (1) Managers perception
concerning performances in market share, profitability, growth in sales, and competitive position in the Industry. (2) HR effectiveness, including employee morale, productivity, and commitment (Yu and Chiang, 2005). Many of the perspectives that nominated the early thinking concerning firm performance have their roots in traditional economic theory with an emphasis on market power and industry structure as determinants of firm performance (Chadwick 1999; Chandler, 1994; Knight, 1997; Wiklund, 1999). For measuring a firm’s performance, objective and subjective measures have been used. The objective measures include measures such as return on assets, market share, sales, export proportion, growth rates in domestic and export sales growth. Similar measures are used by previous researcher (e.g. Hitt et al., 1982, 1985). Similarly, the subjective measures of performance include management’s perceptions of productivity, profitability, market share, and customer satisfaction relative to competitors. The possibility of using subjective performance measures (the management perceptions) was suggested by Dess and Robinson (1984) if the accurate objective measures are unavailable. Subjective measures of performance have been used by several researchers (e.g. Li, 2000, Akimova, 2000). Here the performance indicators used by various research scholars in their work as shown below:


Hitt, M.C, Ireland, D.R and Stadter, G (1982): Price earning; return on equity (ROE); return on capital (ROC); sales volumes and earnings perShare

Hitt, M.C and Ireland, D.R (1985): Market return (Derived from geometric mean annual stock return; geometric mean annual risk free rate and beta measure of systematic risk)

Droge, C. and Vickery, S. (1994): Return on Investment (ROI) and ROI growth; Market share and market share growth, Return on Sales (ROS) and ROS growth

Sharma, Bishnu. and Fisher, Tom. (1997): Sales per employee; Return on Asset (ROA); Market share; Sales; Export proportion, growth rates in domestic; Export sales growth; Perceived performance: productivity, profitability; customer satisfaction; market share

Li, Ling. X. (2000): Sales volume; Profit after tax Market share Return on Investment (ROI)

Akimova, Irina. (2000): Return on Investment (ROI) Profit Sales volume; Market share; cash flow