# INSIGHTS

# LEAN MANUFACTURING

ARRELIC RELIABILITY PVT. LIMITED

**Lean Manufacturing** can be described as a multi-faceted production approach comprising a variety of industrial practices, directed towards identifying value adding processes from the purview of customer and to enable flow of these processes at the pull of the customer through the organisation . It evolved from the conceptualisation of Toyota Production System (TPS) by Taichii Ohno's initiatives at Toyota Motor Company . The central thrust of lean manufacturing is to create a streamlined flow of processes to create the finished products at the required pace of customers with little or no waste. Shah and Ward (2007) performed a comprehensive, multi-step approach based study to identify the dimensional structure of lean manufacturing and developed reliable scales to signify them. They quantified the conceptual definition and measurement of lean manufacturing in ten factors, as mentioned below.

1. Supplier feedback: Critics and performances of products and services received from customers to be periodically communicated back to suppliers, for effective transfer of information.
2. Just-In-Time (JIT) delivery by suppliers: Only required quantity of products to be delivered by suppliers at the specified time when customers require them.
3. Supplier development: Suppliers to be developed along with the manufacturer, to avoid inconsistency or mismatch in competence levels.
4. Customer involvement: Customers are the prime drivers of a business, their needs and expectations should be given high priority.
5. Pull production: An initiation of need from the successor through kanban should enable the flow of production from the predecessor, signified as JIT production.
6. Continuous flow: A streamlined flow of products without large halts should be established across the factory.
7. Setup time reduction: Time required to adapt resources for variations in products should be maintained as least as possible.
8. Total productive/preventive maintenance: Failure of machines and equipment should be avoided by effective periodical maintenance procedures. In case of failure low rectification time is to be maintained.
9. Statistical process control: Quality of products is of prime importance, no defect should get percolated from a process to a subsequent one.
10. Employee involvement: With adequate motivation and entitlement, employees are to be empowered for an overall contribution towards the firm.

**The research work by Shah and Ward (2007) provides a theoretical definition for the term 'lean manufacturing' and validated it by an extensive survey of lean practices in manufacturing industries .It provides an explanation of underlying principles and a clear definition for lean manufacturing in a socio-technical approach (Staats, Brunner & Upton, 2011). This model of ten elements includes people and process elements, as well as internal and external factors, which had limited focus in past research (Dora, Van Goubergan, Kumar, Molnar & Gellynck, 2013). Hence these widely accepted ten dimensions of lean manufacturing are used in our research and are validated for attainability through Industry 4.0 technologies. These ten dimensions are grouped into four major factors, depending on the entities involved in each of the dimensions.**
**Accordingly, the factors as depicted in Figure 2 are:**

- **Supplier factors**
- **Customer factor**
- **Process factors**
- **Control and human factors**

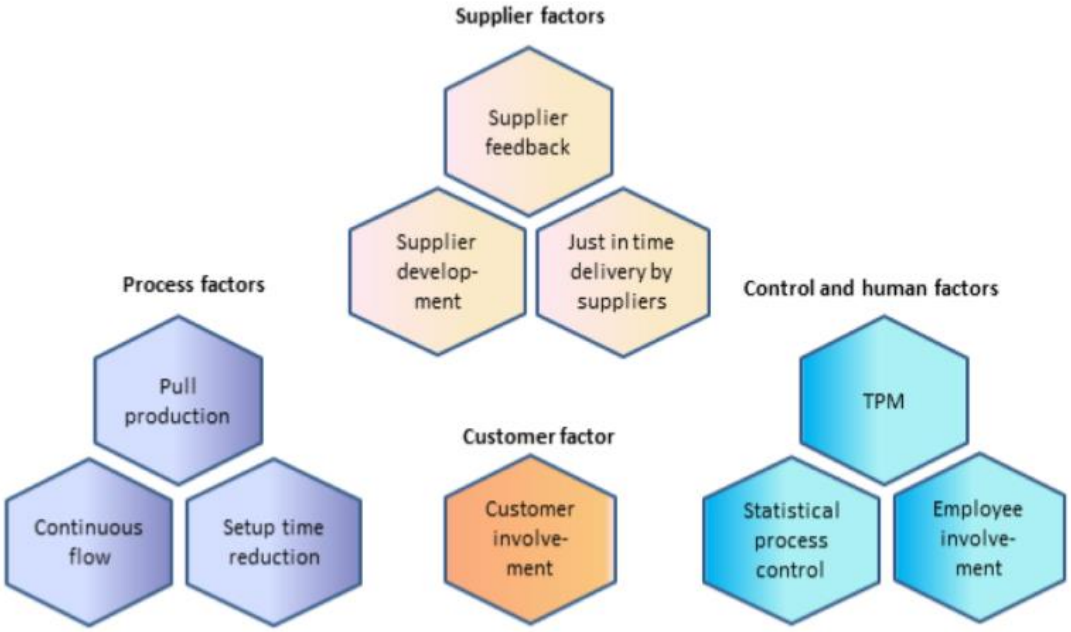
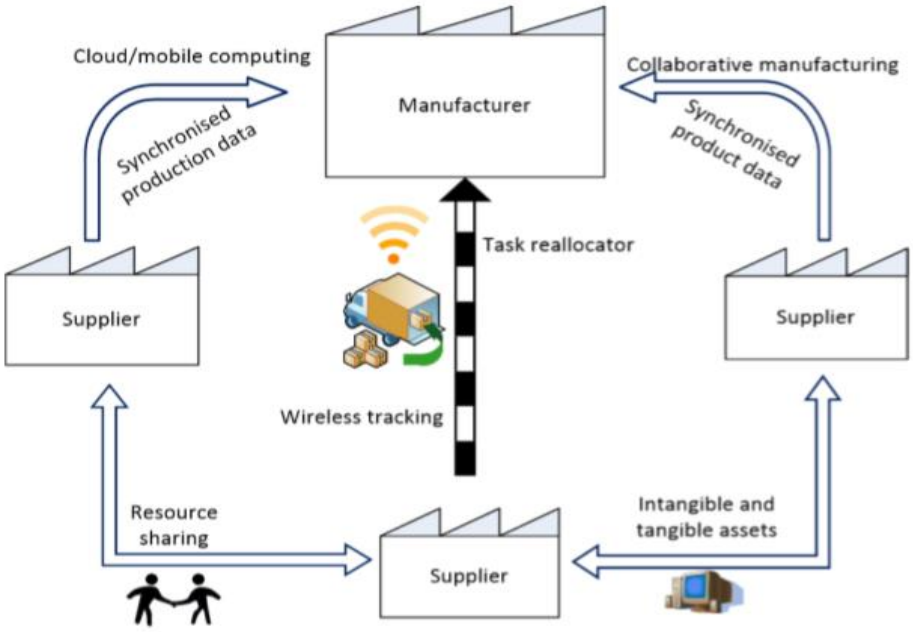



**Figure 2. Grouped dimensions of lean manufacturing**

**The supplier factors are concerned about integrating with the suppliers in the business, and comprise the dimensions supplier feedback, supplier development and JIT delivery. The customer factor is focussed about involving customer into the business processes. The process factors focus on the operations and sequence of the processes, and consist of the dimensions pull production, continuous flow and setup time reduction. The human and control factors, as the name suggests, are concerned about the controlling system and employees. Total productive/preventive maintenance, statistical process control and employee involvement fall under this category.**

## Industry 4.0

**Industry 4.0 is the fourth industrial revolution applying the principles of cyber-physical systems (CPS), internet and future-oriented technologies and smart systems with enhanced human-machine interaction paradigms. This enables identity and communication for every entity in the value stream and leads to IT-enabled mass customisation in manufacturing (Lasi, Fettke, Kemper, Feld & Hoffmann, 2014; Posada et al., 2015; Valdez, Brauner, Schaar, Holzinger & Ziefle, 2015). The term was first coined in 2011 at the Hanover Fair followed by formation of a working group chaired by Siegfried Dais (Robert Bosch GmbH) and Henning Kagermann (Acatech). The Internet of Things and Services enables to network the entire factory to form a smart environment. Digitally developed smart machines, warehousing systems and production facilities enable end-to-end information and communication systems-based integration across the supply chain from inbound logistics to production, marketing, outbound logistics and service. Industry 4.0 also ensures creation of better cooperation between employees and business partners.**




**Industry 4.0 significantly influences the production environment with radical changes in the execution of operations. In contrast to conventional forecast based production planning, Industry 4.0 enables real-time planning of production plans, along with dynamic self-optimisation. Though embedded with latest technologies and intelligent algorithms, the smart factory allows itself to be built on the foundations of the classical Toyota Production System.**

**The introduction of information and communication systems into industrial network also leads to a steep rise in the degree of automation. Intelligent and self-optimising machines in the production line synchronise themselves with the entire value chain, right from order or materials from suppliers to delivery of goods to customers. Simulation of inventory, logistics and transport, and usage history of products also help to positively influence the production processes.**

**In Germany industries are evaluating their readiness towards implementing Industry 4.0. At least 41 percent of German firms are aware of the theme and have started some concrete initiatives. But it is a long way to go and for some industries the topic is still unknown.**

**This applies specifically to little scale ventures where 44 percent of them are unconscious of Industry 4.0; then again it is notable in bigger organizations, where just 17 percent are observed to be oblivious of the term. There likewise exists a slack in execution designs of Industry 4.0 between enormous ventures and SMEs. Almost 20 percent of unique gear producers have strong usage techniques, though even with the gigantic volume of SMEs in Germany, just 17 percent are furnished with execution procedures. These enterprises need to investigate the potential outcomes and advantages related in coordinating all their industrial facility activities. This does concern specialized issues as well as brings up vital administration issues. The activity is broadly spread over the world, called by various names in various nations. Thus the discoveries of this exploration are relevant to Internet of Things (IoT) based assembling control hones in any nation.**

## Incorporation of Lean Manufacturing and Industry 4.0

**Incorporating both the circles of lean assembling and Industry 4.0 is a critical research field to be widely investigated. With the appearance of PC coordinated assembling, there was a hypothesis that processing plants without bounds would work self-rulingly without the necessity of human administrators. In spite of the fact that such an announcement turned out to be infeasible in a handy situation, it offered ascend to the idea of lean mechanization, where mechanical and robotization advancements are utilized to accomplish lean assembling. Taichii Ohno's Toyota Production System depends on two columns: Just in time and autonomation. Autonomation alludes to computerizing the manual procedures to incorporate assessment; i.e. at the point when an issue happens, the gear should stop consequently and not enable imperfections to additionally continue through the line. Just when an imperfection is recognized would a human mediation be required. Henceforth mechanization underway has assumed a vital part appropriate from the commencement of lean assembling, and Industry 4.0 can be considered as progression in this field.**

**In the accompanying segments, the ten measurements of lean assembling from the four gathering factors as per Shah and Ward (2007) are examined and how the innovations and ideas of Industry 4.0 go about as empowering agents to these measurements is assessed**

## Supplier Factors

**The Supplier factors are worried about the stream of products and data from the providers to the maker. It is fundamental for each element in the production network to get synchronized with the adjustments in business procedures of the maker. Likewise, the measurements Supplier criticism, Supplier advancement and JIT conveyance are talked about, and the effect of Industry 4.0**

## Supplier Feedback

**Improper exchange of data amongst makers and providers is a noteworthy wellspring of waste, as for the procedure and additionally the item. Providers should be routinely educated about the status and state of the items and administrations gave by them. This clears route for quick reaction and sufficient activity if there should be an occurrence of any inconsistencies. Be that as it may, distinction in plans of action, task, and information upkeep hones between the makers and providers don't enable producers to effectively discuss data with different business accomplices. Each industry can't have aptitude and assets in all the required fields. Industry 4.0 gives the essential apparatuses to accomplish quick and programmed criticism to providers, to beat administrations and deficient correspondence channels. Simply through advanced cells and tablets associated with the web and normal cloud, simple combination and better relationship could be kept up between the business accomplices. In this manner cooperation, synchronization and better correspondence systems fill in as empowering agents to keep up viable Supplier input.**

## 5.1.2. Just in time Delivery by Suppliers

**The Just in time logic advanced through the Toyota Production System requires a stock level of significant worth zero. Just the required number of items should achieve the maker at the ideal time, without the need of putting away them before being utilized. In any case, in exhibit coordination frameworks, this auspicious conveyance isn't generally conceivable because of reasons, for example, deficient status of products being delivered, crisscross between the required and transported merchandise and unforeseen time delays amid exchange of products. Web of Things is outfitted with various incorporated gadgets for correspondence, which oversee data about products transported. Each thing as of now put away with a conveyance note, would be followed remotely about its starting point, goal and the present status. Labeling each thing guarantees sending of right items to the right goals and diminishment of lead times of dispersion. This guarantees auspicious conveyance of the things, as well as enhancement of the movement courses and dependability in coordinations. A Supplier is engaged to remark when precisely his products would achieve the client, in this way improving validity and enhancing clients (Bose and Pal, 2005; Caballero-Gil, Molina-Gil, Caballero-Gil and Quesada-Arencibia, 2013). On the off chance that a convenient conveyance isn't conceivable because of some unanticipated congested driving conditions or some other limitation, a keen undertaking allocator would start a recreated exchanging process, where a request is reallocated to fulfill the requesting time requirements (Fischer, Müller and Pischel, 1996). Hence labeling each thing, remote following and savvy reallocation of requests are seen to fundamentally advance Just in time conveyance of products by providers.**

## Client Factor

**The client factor focuses on taking into account the necessities of client and incorporating them with the business procedure, keeping in mind the end goal to accomplish lean assembling. The measurement client contribution is talked about in the accompanying segment.**

## Client Involvement

**Against the across the board pattern of specifically simply giving items and answers for clients, clients' inclusion must be set up appropriate from item advancement stages. Clients are the core for a business to survive and consequently their affiliation ought to be considered of high significance. Be that as it may, once the details are set for assembling, clients are furnished with next to no adaptability to change them at a later stage. 5.3. Process Factors**

**The arrangement of activities performed in the shop floor and the stream of items appropriate from the phase of crude materials to the completed products are noteworthy elements to be considered to actualize lean. These variables are talked about underneath, and a representation portraying the effect of Industry 4.0 on these elements is appeared in Figure 4.**

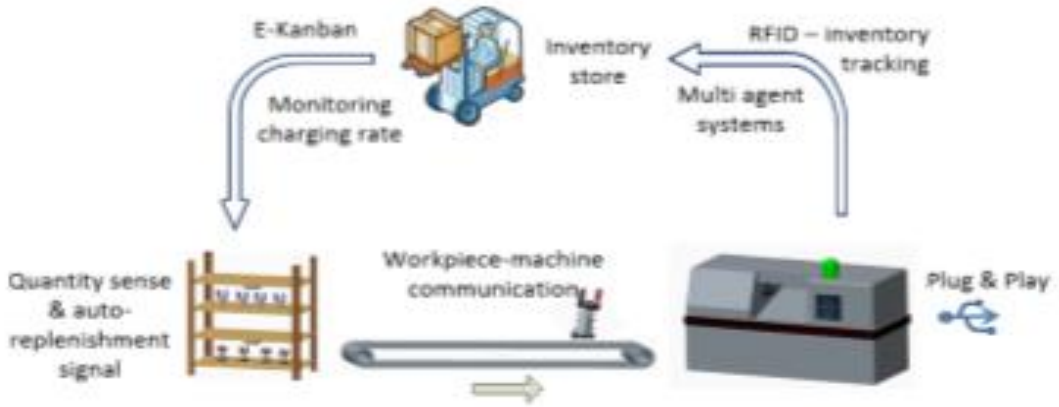



Figure 4. Impact of Industry 4.0 on process factors

## Add up to Productive/Preventive Maintenance

**Shortcomings or disappointments of machines amid generation prompt unfriendly impacts on calendar of creation and additionally assurance of the workers. Organizations take endeavors through preventive and periodical support plans however disappointment of machines are not generally under control. Generation gets upset if there should arise an occurrence of a machine breakdown, and frequently extensive time is spent to discover the underlying driver and take care of the issues. In a shrewd production line with machines interconnected with data and correspondence frameworks, when a machine separates, it sends mistake warnings to particular shop-floor and support staff. The upkeep specialist at that point checks the mistake code for arrangements and gets fundamental instruments and parts for repairing. In the interim the assembling execution framework can reschedule the occupations to moderate the effect of breakdown (Lucke, Constantinescu and Westkämper, 2008). With further developed examination and enormous information condition, machines are prepared to act naturally mindful and self-kept up. Such machines survey their own wellbeing and debasement and use information from different machines to maintain a strategic distance from potential upkeep issues (Lee, Kao and Yang, 2014). The capacity to foresee potential breakdown and distinguish underlying driver should be produced in the control frameworks. For instance, undertaking asset arranging frameworks have included far reaching systems for prescient upkeep. It coordinates between machine information, ERP information, tangible information and prescient calculations (Haddara and Elragal, 2015). So machine-laborer correspondence, self-upkeep evaluation and prescient support control framework remarkably enhance the aggregate gainful and preventive upkeep in the processing plant.**

## Factual Process Control

**The nature of items is of prime significance in any assembling industry. The procedures must be constantly under control and a few strategies have been produced in the field of value administration to assess forms. Be that as it may, diminishing item lifetime, diminishing improvement time, focused estimating and expanding item intricacy push process control under high hazard. Numbness of administrators playing out a task and powerlessness to track the procedure for varieties contribute essentially for quality deformities in items. In the situation of Industry 4.0, brilliant items accompany insights about the tasks to be done on them. The grouping of activities to be performed on an item is as of now stacked onto the bearer of that item. This data is as of now passed on to the machine for robotized activities, and appeared with better representation interfaces for manual tasks. Enhanced man-machine interfaces likewise display data in an all the more engaging way, and dodge plausibility of committing errors in the generation forms. RFID empowers programmed detecting of procedures for varieties by perusing the separate data put away in RFID labels. IoT aids incorporation of various esteem including forms by joining data and information from various machines. Progress examination consolidates business insight alongside administration.**

## About Arrelic

Arrelic is a fast-growing deep-tech firm aiming to bring the next level of IoT based sensor technology to transform the mode of manufacturing operation and maintenance practice of various industries with extensive expertise in Reliability Engineering, Predictive Maintenance, Industrial Internet of Things (IIoT) Sensors, Machine Learning and Artificial Intelligence. We provide a single ecosystem for catering all industry needs from Consulting to IoT and Analytics as well as providing Training and Development courses for different stakeholders. We aim to help manufacturing industries to improve their overall plant productivity, reliability and minimize total production cost by 25-30% by eliminating machine downtime, lightening management decisions by analysing the machine data with right mind and expertise; for a worry free operation.

## For more information reach out to us at :

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