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A study on influence of technology on lean manufacturing

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Abstract - Automation in manufacturing sector has become a subject of great interest nowadays. This paper emphasizes on overall technology impact in lean manufacturing and eliminate waste will enhance the quality of work culture. Technology is now widely diffused to all organizational levels. Fundamentally, it does not only require a technological understanding, but also a greater understanding of the social, behavioral and cultural factors, which can impede or facilitate change, as users interact with technology. One of the technologies is lean manufacturing system is useful to ensure production process in a manufacturing company to run smoothly without any interruption. It is observed that the things in many ways goes waste which directly affects the cost and quality of the product. So it becomes essential on the part of manufacturers to reduce the all type of waste.
The objective behind this study is how influence of technology on lean manufacturing by using downsize waste and while simultaneously maximizing productivity with the help of technology.

The report is based on secondary data. In Secondary data there is the use of related material, research papers, journals, books etc. For the analysis purpose and Major Findings are Lean with technology improved efficiency frees up employees and resources for innovation and quality control that would have previously been wasted. Less waste and better adaptability makes for a business that's better equipped to thrive well into the future. With the help of innovation; staff are fully involved so improved morale and participation in the business. And, of course, it will effect on the productivity which improve with less waste and ultimately effect on quality make for more profit. The basic conclusion of this study on influence of technology on the lean manufacturing measures may not be easily drawn. However, this initial study have presented some key indications that technology will enhance the efforts of lean manufacturing initiatives and thus enable a more efficient and productive manufacturing sector in the future.

Key Words: *lean, technology, waste, quality, innovation, quality control.*

1. Introduction

Lean manufacturing is a methodology that focuses on minimizing waste within manufacturing systems while simultaneously maximizing productivity. Lean is also known as lean production or integrated sociotechnical approach which is based on Toyota production system. Achieve maximum efficiency by developing operations at minimum cost and with no wastage is the main goal of lean manufacturing.

To do so, the model aims to act upon the causes of variability or losses, and upon the causes of inflexibility with a view to achieving an improvement in quality, costs, and delivery and other times. Lean is based on a number of specific principles, such as kaizen, or continuous improvement. The lean production system result in productivity gains by highlighting waste. It result in quality gains by making problems visible when and where they occur and then by having the internal customer take measures to solve the problem to prevent recurrence. Lean manufacturers learn how to get continuous improvements in productivity and quality by continuously re-designing and making the manufacturing system simpler. The critical element in that redesign the internal customers who are truly empowered and trained to analyzed, resolve, and prevent problems.

As mentioned, going lean starts with eliminating waste to focus on what adds value to process, which leads to adding value for customers. There are eight types of waste such as Defects, Overproduction, Waiting, Non-utilized talent, Transportation, Inventory, Motion, Extra Processing.

Technology is the sum of techniques, skills, methods, and processes used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation. Technology can be the knowledge of techniques, processes, and the like, or it can be embedded in machines to allow for operation without detailed knowledge of their workings. In the last couple of decades, lean manufacturing has seen huge growth as a way of identifying and eliminating waste, or activities and resources that do not add value.

Early adopters of lean methodologies were satisfied with simple, manual solutions and the flexibility they provided, which may help explain why some practitioners say the most high-tech tools that lean should involve is paper, pencils and spreadsheets. Yet a number of technological advances and external pressures ever-escalating customer expectations, pricing pressures and expanding supply chains are making technology less likely to go head-to-head with lean today.
Choosing to implement technology to support lean management efforts is an important first step on the path to continuous improvement. However, research continues to stress the importance of the effect of technology on lean manufacturing programs. We specifically examine the relationship between the factor of technology and lean

systems. This contextual factor has been suggested as a possible facility to implement lean manufacturing systems.

2. Literature review:

The aim of this paper is to analyzed the relationship between various technology implementation with lean tools and their impact on companies. Based on the literature review carried out, we have identified the most common and used technologies and lean tools. In order to validate these quality management and lean practices.

This study attempts to investigate the technology required in implementing lean manufacturing system in a manufacturing company. This system is useful to ensure run production process in operation smoothly without any interrupted.

The concept of lean manufacturing was developed for maximizing the resource utilization through minimization of waste, later on lean was formulated in response to the fluctuating and competitive business environment. Due to rapidly changing business environment the organizations are forced to face challenges and complexities. Any organization whether manufacturing or service oriented to survive may ultimately depend on its ability to systematically and continuously respond to these changes for enhancing the product value. Therefore, value adding process is necessary to achieve this perfection; hence implementing a lean manufacturing system with technology is becoming a core competency for any type of organizations to sustain. The majority of the study focuses on effectiveness of the lean tools in the organization.

3. Analysis

Like previous industrial revolutions, new technological developments are driving industry forward. Cyber-physical systems (CPS) and the industrial internet of things (IIOT) are the most relevant of these new technologies for lean manufacturing. For make it easy to overlook the potential positive cultural impact from these technologies is fear of automation, and other manufacturing workforce challenges. New technologies is an opportunity to access core objectives for lean manufacturing.

Defining the enabling technologies:

Cyber physical systems is define by Wagner, Hermann and Thiede for "the result of a closed loop of sensor-based physical process data acquisition combined with cyber data processing and autonomous actuator based process controlling connected with the internet, its data, and services."

Cyber-physical systems (CPS) is nothing but the collecting and connecting of data from production via a network to the cloud. In a cyber-physical system there are three primary ways to collect data such as human to machine, machine to machine, and data acquisition and processing.

1. Human to machine

Human to machine is primarily sourced of data collection from operators via a digital interface. With the help of human to machine CPS can collect information through traditional data entry, methods like typing into a computer or selecting options on a tablet. Operators can also share information through advanced technology. For example, computer vision can collect data from specific gestures or movements that have assigned meaning.

2. Machine to machine

Machine to machine is historically communication meant a pushing data to machine into another machine. These machines were usually connected through an Ethernet connection. M2M communication is full potential of was limited by siloes, proprietary technology. IOT transforms m2m communication in two significant ways. First is involves communication both ways, versus just a push from one machine to another. Second is adding the cloud is enabling greater possibilities between machines. Potentially unlimited integration options is provides by M2M .

3. Data acquisition & processing

Many manufacturers are use other software for preparing and collecting data. They use enterprise resource planning (erp) software to manage, purchases, financial planning, employee and other aspects of business. For track and trace materials they use manufacturing execution systems . CPS system is use for push data into these and other systems, or pull production critical data from these systems ultimately, combine that data into deliver a interconnected and holistic vision of production.

Technology reduce waste, improve efficiency and drive results with the lean:

Organizations with the help of technology strive to create lean logistics operations. After all, eliminating waste it will reduce costs and saves time, and it beneficial to each member of the supply chain.

These technologies help companies achieve lean operations at a faster rate and with more success than ever before, are as follows:

1. Asset tracking
2. Big data tools
3. Business intelligence (bi) software
4. Predictive analytics and real-time modeling tools

1. Asset tracking

Asset-tracking is use for automatic identification technology like RFID, barcodes, barcode scanners and handheld devices to help workers locate assets and inventory. These technologies eliminate waste as well as lead to lean operations by saving time, reducing capital expenditures, creating more efficient workflows, reducing paperwork and improving inventory efficiency.

Asset tracking is also should work in real time so everyone connected to it can see how items are used and how often. Top

management can identify bottlenecks and opportunities for improving productivity when utilizing real-time asset-tracking solutions.

2. Big data

Big data is excessively large amounts of data, typically in raw form. Top management can make data-driven decisions with the help of big data . It's the actionable analytics and insights that come from big data that lead to increased efficiency, improved productivity and decreased costs. Big data gives logistics executives power to consider all supplier and customer flows at once. An data that exists in silos results in a limited view of operations or an incomplete view such as missing data from pertinent sources. This compromises their ability to become lean.

3. Business intelligence software

Business intelligence (BI) software have the ability to harness big data and increase visibility to conduct trend analysis as well as to develop data-driven business strategies to promote lean operations. BI software solutions observe historical trends and gain the insights they need to reduce waste and take smarter decisions. Bi solutions deliver detailed reports to logistics leaders. They have the capabilities to analyze loads, slotting, and wait times and find opportunities for saving time and money.

4. Predictive analytics and real-time modeling tools

Predictive analytics is technology that organizations need to have in order to achieve lean operations. Predictive analytics use big data to maximize forecasting capabilities. With predictive analytics, statistical methods and models to analyze historical and current facts to make predictions used by organizations. Predictive analytics is more accurate and complex than traditional demand forecasting, offering the ability to predict outcomes on both granular levels and broad. The analytics gain from utilizing real-time modeling tools make it possible to optimize labor and other resource utilization.

Other referred technologies and their impact on lean:

In this section, a set of technologies that are pointed out in the studies included in this systematic review as disruptive tools enabled by technology are analyzed, as well as their impact on lean practices.

1. Cloud manufacturing to reduce wastes

A cloud computing-based application able to process inputs for electronic work instructions creation and standard work generation has been developed by Silva et al. The application relies on technology principles and allows real-time access of information and integration with other computational systems within the company, being able to automatically create work instructions. Cognizant computing provides real-time databases that are mainly supported by cloud computing and powered by IOT technologies. The identified benefits are related with increased financial savings and returns, reduction in lead-times, inventory volumes, process wastes and less rework. Furthermore, this technology can provide a better understanding about production processes, tasks and needs of customers. The available real-time information provided by cognizant computing will allow managers and executives to make better decisions, reducing wastage, minimizing business risks and ensuring a better customer satisfaction.

2. Virtual and augmented reality to virtualize lean tools

Virtual reality (VR) technology can be combined with CPS networks that provide real-time data in order to create virtual VSM, which is one of the core lean practices. The virtual VSM allows every stakeholder to be immersed in a virtual model, observing and mapping current and future state of processes, without the need of understanding the conventional VSM symbols that have firstly introduced the lean automation concept, presented an approach that consisted in the use of AR and CPS-based wearable devices that provide information to operators about cycle time and tasks to perform via AR, in order to support JIT production. Furthermore, the wearable devices are able to receive failure information and display it in real-time to operators regarding to problem-solving processes, VR and AR technologies can enhance efficiency and performance, providing additional real-time information. Furthermore, these visualization technologies allow the examination of hazardous situations, maintenance and training scenarios, holding a huge potential to completely change and revolutionize the way humans work and communicate.

3. Autonomous and collaborative robotics for cooperative and flexibility manufacturing systems

That addresses the cooperative relationship between humans and technology that is being enhanced by technology framework. However, most of these approaches do not consider the interaction and communication between human and robots, and authors argue that and adaptation of conventional methods in order to be suitable for analyzing hybrid production workplaces is required in technological context, considering every aspect, such as communication interface, robotic system control, social structures and individual consequences. The system is able to work with flexible production flows and fast changing environments, responding to unpredictable changes and providing an efficient, reliable and predictable path-based navigation.

However, robots are flexible enough to fast react to obstacles and persons, avoiding them and blocking their way, meeting the safety challenges of service robot fleets. The proposed system is supported by collaborative robots and its main operating principle is the reconfigurable real-time measurement, which allows the users to change instantly between manufactured products, increasing production capacity, decreasing set-up times and investment costs and allowing the capacity adjustment and the production of small batches in a single manufacturing system.

4. 3D printing

Chen and Lin presented a discussion about 3D printing technology, focusing on the technical challenges that must be addressed before its implementation and the main managerial concerns that can influence the cost effectiveness of manufacturing systems. The 3D printing technology facilitates the achievement of lean manufacturing principles, pointing as main benefit the small batches production, since this technology allows a print-on-demand production systems, which eliminates inventory and promotes pull systems. Furthermore, this technology allows JIT manufacturing, decreasing the lead times and enhancing logistics efficiency, since 3D printers can be installed near customer's location, in order to reduce distance and delivery costs. Regarding human factors, with 3D printing implementation, more tasks are performed by machines, which reduces wastes related with overburden or unevenness workload, improving employees' well-being and releasing them to focus on continuous improvement processes. Such as 3D printing, potentiates smart product development processes, improving their efficiency, while this technology is useful to produce complex parts, which cuts down setup times, enabling the one-piece flow production.

5. Video-based models and 3D models

This system captures information about the way tasks are performed by the operator, being able to detect anomalous events that are linked with video data for further analysis. Based on this, the system is able to detect best practices and generate event list enriched with video data and KPI to analyze the operator's performance. The collected information is useful for continuous improvement processes and the identified best practices are used for standard work instructions and information sharing within the company.

6. Optimization algorithms

This tool aims to address lean thing principles in the context of technological framework, using ambient intelligence, optimization heuristics and machine learning. The main purposes of this decision support system consisted in process automation, real time data updates, implementation of electronic work instructions, provide analytical support in the decision making process and apply ambient intelligence approaches that allows complex analysis and learning, in order to respond to dynamic environments. Moreover, optimization approaches that intend to enhance problem-solving and decision-making procedures.

7. Simulation

The simulation technologies can be very useful for reconfiguring and analyzing production systems. However, these practices can be enhanced by 3d laser scanning in order to capture and digitalize spatial data, proving information to simulation models. Nafors et al. Propose a simulation model supported by 3d scanning and VSM, which facilitates the understanding about an existing production system and increases the flexibility regarding when designing a new production system. The efficient and effective tool for planning, control, as well as for ensuring a correct reconfiguration of manufacturing resources and production flow. Furthermore, a simulation-based real-time solution for production planning has been described that resulted in a drastic reduction of the inventory levels on manufacturing environment through the achievement of production on-demand and JIT delivery of components. This solution has increased vehicle utilization, productivity and efficiency, providing flexibility to rapidly reconfigure logistic system and optimizing the material flows.

Critical analysis lean tools supported by technologies

The systematic review is focused on how technological impact can enhance lean practices. The objective is to understand the relationship between technology and lean tools, as well as assessing how the implementation of these technologies can improve lean practices presents a summary of which technologies impact and support which lean practices. CPS is referred by technology that can be effectively used to enhance lean practices. CPS provides real-time data that can be used to give instant visual feedback regarding performance (KPI) and provide transparency and better communication between production stakeholders. This technology can be helpful in simplifying the use of Andon and E-Kanban systems, as well as, other production pull flow control techniques. The pull flow is a key lean principle. Regarding maintenance, CPS are able to collect data about maintenance needs and automatically send signals to maintenance staff.

Table: Lean tools supported by technology

Lean Practices	Technologies									
	CPS	IOT and IIOT	Big data and Data	Cloud	VR and AR	Robotics	3D Printing	Simulation	Video -based and 3D	Optimization Algorithm
VSM			X		X			X		
Standard work	X		X	X		X			X	X
Continuous improvement and waste elimination	X	X	X	X	X	X	X	X	X	X
Andon	X									
Heijunka and production planning	X	X						X		X
Pull production	X						X			
Jidoka / Autonomation	X					X				
Kanban	X							X		
JIT	X	X					X	X		
Supermarket	X									
Milk run										X
Problem-solving and decision support	X	X	X	X	X					X
KPI	X		X					X	X	
Empowerment and involvement of worker			X							
Improved human factor					X		X			
Six Sigma	X	X	X							
TPM	X			X						
Communication and information sharing	X	X	X	X	X	X		X	X	
Decreased operation and waiting times	X		X	X		X	X			
Decreased stocks and inventory management	X		X	X			X	X		
Increased flexibility	X		X			X		X		X

4. Conclusion

As globalization intensifies competition among manufacturers, there is an immense pressure for organizations to achieve higher level of manufacturing performance. Lean manufacturing has been a beneficial approach in improving productivity and this study has shown that the upcoming technologies have the potential to further increase that and create a benchmark. It is now essential to tie up lean manufacturing with technology so as to expedite lean management movement. The industries totality should move forward to take up this task and more execute possible efforts to update the various events through lean principles. Now it is high time to move up for stability as far as global scenario is concerned. It is not that much difficult or complicated to operation for lean management drive. This will not only help the industries to downsize the waste also will enhance the quality of work culture. It has been proved by number of companies that lean manufacturing is a need of today and future of tomorrow.

Therefore a conclusive statement about the influence of technology on the lean manufacturing measures may not be easily drawn. However, this initial study have presented some key indications that technology will enhance the efforts of lean manufacturing initiatives and thus enable a more efficient and productive manufacturing sector in the future.

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