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Role of value stream mapping in process development: A Review

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Abstract
In the present competitive era, it is most essential for manufacturing industries to work efficiently and adopt contemporary management practices like lean manufacturing, process integration, and inter-organizational collaborations. The effective implementation of lean manufacturing tools helps to eliminate the wastes along with their causes and also helps to eliminate them, achieving higher quality, effective process flow and to deliver the product at a reduced cost. The current paper addresses the role of implementation of a lean manufacturing tool i.e. value stream mapping in process development in the context of the manufacturing sector.

Keywords
Lean principles, value stream mapping, manufacturing sector, non-value-adding activities.

1. Introduction
The execution of lean manufacturing principles might result in making an enterprise leaner from the beginning and needs less improvement during its lifetime. Lean aims to make the work simple enough to comprehend and to manage the work effectively. In order to undertake these aims, one of the best method is the execution of lean thinking philosophy. This is the process undertaken by Toyota as it helps its suppliers improve their own production. The closest equivalent to Toyota's mentoring process is the concept of 'lean sensei', which encourages companies, organizations, and teams to seek outside, third-party experts, who can provide unbiased advice and coaching (Rahul and Kaler, 2013). The application of the lean theory has confirmed to be an effective way of improving manufacturing systems through eradicating the non-value-adding activities (NVAs) and it is often mentioned to as a philosophy, as a way of thinking. Various studies and case study have been conducted for analyzing a particular process and drastic improvement in the different fields or services of the organizations (Garg *et al.*, 2016; Mor *et al.*, 2016; 2017; Bhardwaj *et al.*, 2018). VSM is used to illustrate the flow and relationship between work processes. A key component of VSM is differentiating the value adding activities from non-value adding activities. Reducing or eliminating NVAs is of paramount importance and a principle goal of lean manufacturing. VSM is the process of mapping the material and information flows to be required by manufacturers, suppliers and distributors to perform the activities and to deliver products to customers.

VSM specifically provides the inventory, process time, lead time, waiting time, etc and process flow from which we can find out bottleneck cycle time against Takt time (Nordin *et al.*, 2012). Value stream includes all the specific activities (both value-added and non-value-added) needed to bring a particular product by implementing three important management skills of any business that are problem solving, information management and physical transformation. A value stream map uses symbols to represent the flow of information and inventory within a system and to streamline those processes. It's a tool for reducing waste and improving efficiency, with the goal of providing optimum value to customers in the form of products or services. Value stream mapping has supporting methods that are often used in lean environments to analyze and design flows at the system level (across multiple processes). This paper gives an extensive review of literature related to execution of a lean technique i.e. value stream mapping (VSM), for eliminating the waste, and to deliver the goods efficiently and effectively to the customer with enhanced quality. This gives the broad area of lean adaptation in various sectors following the improved process flow, improved quality at reduced costs. The literature has been used for this work as follow.

2. Literature Analysis

Faisal (2016) carried out the Simulation modelling of leather small and medium enterprises (LSME), performed on ARENA software using value stream mapping, one of the important lean tool to identify the impact of LM. By implementing pull system the output increases and WIP decreases. Cirjaliu and Draghici (2016) studied the possible impact of lean manufacturing, both positive and negative on the occupational ergonomics which is helped by the 5 scientific solid materials from different domains. Choomlucksana *et al.* (2015) explored the processes having most non-value added activities and should be addressed as quickly as possible. Authors reduced the process timing by 62.5%. Ramos *et al.* (2015) designated the lean tools and simulation to improve the overall efficiency of a packaging line of visual communication boards and found that line balancing as major cause of low productivity. Rohani and Zahraee (2015) conducted simulation and found that the production line of paint paste is bottleneck & applied VSM, one of the most important tool in color industry to identify and eliminate the wastes. Rane *et al.* (2015) reviewed the vehicle assembly line optimization and found that there is increased application of simulations & optimizations for the vehicle assembly line throughout the previous years. Bon and Kee (2015) conducted a case study in Malaysian company, the data was collected and the results were further analyzed using NIVIA10 software. With the help of VSM and gap analysis, it was found that the top management is the most crucial factor among the 10 key success factors of lean implementation identified. Dos *et al.* (2015) studied the implementation of lean and working conditions and presented that how the better working conditions help in process improvement and improved product quality. Kumar (2015) conducted a case study and found 20% reduction in cycle time while using some lean tools such as VSM, Kaizen, FMEA and Time & Motion analysis, and significant improvement of producing 12000 units/month instead of 9500 units/month earlier. More and Pawar (2015) studied the textile industries located at Maharashtra and found that a preference to ISO: 9000 standards over the other strategies like Six Sigma.

Sundar *et al.* (2014) described the principles about the various lean manufacturing tools to eliminate the wastes and to improve the quality at lower costs. Kumar and Kumar (2014) found that with balancing the imbalanced line of truck body assembly the cycle time was reduced and the efficiency was increased up to 30.09% from 17.5%. Kumar *et al.* (2014) carried out the method study in well reputed manufacturing industry which manufacture the variety of hydraulic cylinders. Then with the implementation of LM concepts in the problematic areas there is reduction in setup time along with increase in productivity (50%). Bertolini and Romagnoli (2013) found that there is 50% rise of throughput rate studied that with the implementation of lean manufacturing tools, if compared with the previous value, moving from 1 to 1.5 valves per hour. Also, the lead times were decreased by 80%, by reorganizing the shop floor in a one-piece-flow logic. Kruger (2012) suggested that cellular manufacturing is best suited for application in make to order manufacturing systems, the single most approach used to produce high variety and low volume products. Thammatutto *et al.* (2011) developed a flexible model of manufacturing using the simulation so as to improve flexibility using VSM and presented how it can help in improving the productivity and flexibility, as well as dropping the overall production cost.

2.1. Literature analysis in tabular form

Given below is the literature analysis in a tabular form.

Author(s)	Objective of Study	Year	Observations
Bhardwaj *et al.*	A case study finding the root cause of rejection followed by action plans.	2018	The productivity was improved significantly by reducing the overall time that was previously consumed in unnecessary activities.
Mor *et al.*	Exploring the causes of low-productivity in dairy supply chain.	2017	The poor logistics and transportation facilities is the most critical factor as productivity barrier in the context of cooperative milk processing units in India.
Mor *et al.*	Literature review on lean production in relation to the green concept.	2016	Lean principles along with green model can improve the process flow & employee morale and lower the environmental regulatory non-compliance risk.

Garg *et al.*	Execution of single minute exchange of die on corrugation machine	2016	The application of SMED resulted in reduction of 86.6% in setup/changeover time and hence a significant saving in cost.
Mor *et al.*	A review of supply chain practices in agri-food sector.	2015	Lean production is a way to improve processes and to improve the process effectiveness in an industry.
Rahul and Kaler	To explore the causes of low-productivity in a manufacturing industry	2013	Lean principles along with Juran's methodology helps to eradicate the low productivity causes.
Kruger	Implementing cellular manufacturing in a make-to-order system.	2012	Cellular manufacturing is best suited for application in make to order manufacturing systems.
Bertolini and Romagnoli	Lean manufacturing in the valve pre-assembly area of a bottling line	2013	With the implementation of LM, 50% rise of throughput rate was achieved. Also, lead time decreased by 80% by reorganizing the shop floor in a one-piece-flow logic.
Sundar *et al.*	Review on lean manufacturing techniques.	2014	The study addressed as an overview of the past studies about the various modules of lean manufacturing.
Kumar *et al.*	Application of lean manufacturing in mass production system	2014	A reduction in setup time along with increase in productivity (50%) was achieved with the implementation of VSM.
Choomlucksana *et al.*	Improving the productivity of sheet metal stamping subassembly area	2015	Along with the lean tools applied to sheet-metal stamping process, the process time was reduced by 62.5% and NVA's reduced by 66.53%.
Kumar *et al.*	Cycle time reduction of a truck body assembly in an automobile industry	2014	With line balancing, the cycle time get reduced and the efficiency increased upto 30%.
Ramos *et al.*	Improving the productivity of a packaging line	2015	Authors eradicated the unbalanced line issue and the productivity increased by 40%.
Rohani *et al.*	Production line analysis via VSM	2015	VSM, one of the most important tool, was implemented, and the manufacturing lead-time decreased significantly.
Rane *et al.*	Improving the performance of assembly line	2015	An increase in the application of simulations & optimizations was found for the vehicle assembly line.
Bon *et al.*	Implementation of lean manufacturing for productivity improvement	2015	Through the VSM and gap analysis, it was assessed that the top management is the most crucial factor among the 10 key success factors of lean implementation.
Kumar	Cycle time reduction in a Textile industry using lean tools	2015	20% reduction in cycle time was realized through lean tools such as VSM, Kaizen, FMEA and time & Motion analysis. Hence, an improvement in production of 12000 units/month instead of 9500 units/month earlier.

Cirjaliu *et al.*	Ergonomics issues in manufacturing		Study explored the possible impact of lean manufacturing, both positive and negative on the occupational ergonomics of different domains.
Faisal	Simulation modeling and analysis of VSM in SMEs	2016	Authors identified the impact of lean and simulation modelling on ARENA software using VSM.

3. Conclusions

Value stream mapping is such an optimization tool that eliminate the non-value added activities involved in a manufacturing process thereby maximizing the product value. In this context, a case study is conducted to assess the impact of implementation of value stream mapping in a sports goods manufacturing industry. The current paper focus on the review of the literature related with lean principles and the value stream mapping tool. The findings of studies suggest significant role of value stream mapping in improving the process efficiency, reducing the manpower and appreciable amount of manufacturing cost reduction. With the implementation value stream mapping for various manufacturing processes, more optimum results can be obtained. Future studies can be conducted in order to relate the impact of value stream mapping practices on overall organizational strategies in this context.

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