Application of Lean Concepts in textile manufacturing company in Argentina

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Abstract: Looking for new ways to improve productivity and achieve good efficiency margins in overall production, companies have focused on evolving in terms of organizational structure to reflect better performance. The main objective of this dissertation is to implement improvement processes to increase the operational efficiency of the company R&A Indumentaria, a textile manufacturing company situated in Buenos Aires, Argentina. The implementation of a philosophy that continuously seeks changes towards excellent processes is being presented, also known as Lean Manufacturing. This working concept involves waste reduction, elimination of critical points and improvement of customer satisfaction.

A thorough description of the company activities is developed as well as a contextualization of the textile industry in Argentina for a better understanding of the situation and problems that may be encountered in the company. A critical analysis carried out led to the identification of possible areas of improvement by applying LM.

After conducting a literature review, the Kaizen philosophy and the lean tools – Value Stream Mapping, Root Cause Analysis, 5S and Visual Management – were analysed alongside other processes and improvement tools such as changes in material stock management process to improve customer satisfaction and inefficiencies in the production sector.

Finally, to achieve the purpose of this research the results were compiled to create a specific lean implementation roadmap which consists of a list of steps and processes to apply in the textile company R&A LM tools.

Keywords: *Lean Manufacturing; Value Stream Mapping; Kaizen; Textile industry, 5S, Productivity*

1. Introduction

Lean Production systems have been known by companies as a trend to help them improve their results by cost reduction. It follows a methodology that incentives companies to look at their processes and define which are adding value activities and which are streams of waste. (Womack, 1990). Globally textile manufacturing was one of the first industries that developed lean manufacturing as the predilected way of operation, jointly with the automobile industry (Holweg, 2007). However, in Argentina until a few years ago companies were inclined towards more traditional production methods. This situation is being reversed, giving ground to the implementation of concepts such as lean manufacturing that seek continuous improvement in processes with activities that only add value to the product and reduce to a minimum those that do not (Melton, 2005).

The main objective of this paper is to develop a target analysis of possible lean manufacturing tools to implement in the Argentinian textile company R&A Indumentaria. Also, familiarize with best-practices methods that can contribute to a sustainable workflow toward production excellence and eliminate any activity for which the customer is not willing to pay (Chen et al., 2010). The case study presented intends to give lean practitioners a reference for implementing lean systems in small manufacturing operations.

The remainder of the paper is structured around a literature review of lean manufacturing, both

the organisational philosophy involved and some of the tools that complement it. This is followed by a contextualisation of the case study company, its production operations and the problems encountered during the survey period. And finally, the previously exposed issues are merged to propose specific LM tool improvements to be carried out in R&A.

2. Lean Manufacturing

2.1. Lean Methodology

The concept of Lean Manufacturing is studied and used in a wide-ranging variety of industries, being one of the most influential manufacturing paradigms of recent times (Holweg, 2007). Lean Manufacturing is a concept that arises in the Toyota Production System (TPS), which refers to the Lean concept as tools that serve in the identification and elimination of waste called Muda, by performing this process efficiently, it will generate not only quality improvement but also reduction of time and cost of production (Gonzalez, 2007). As the concept of LM is constantly evolving, and as such, trying to define it definitively is like trying to take a photograph of a moving object (Hines et al., 2004).

2.1.1. Lean Production

According to Womack and Jones (2003), there are five lean principles for guiding the implementation of lean techniques: 1. Identify Value; 2. Map the value stream; 3. Make the value-creating streamflow; 4. Pull between steps; 5. Seek perfection. Whilst the author Shah and Ward (2007) describes having a Lean Manufacturing mindset as a multidimensional approach that encompasses a range of management activities where it can be complemented with what Hines et al. (2004) stated that value is created whenever internal company waste is reduced and whenever new features valued by consumers are offered to them, concluding in a more generalized focus on the Lean Production idea. Adding as well that the main motivation to succeed is to work around the wastes before adjusting any production process and have a very clear picture of this matter.

The last important concept to take on a lean manufacturing focus in an organization is the term continuous improvement. Melton (2005) states that aiming for perfection is equal to a never-ending cycle of applying the concepts described before. Cultural changes can be the hardest part to overcome when new ideas are presented. Investment in time and effort to support the process of adaptation towards Lean can result in sustainable organizations that truly care for this production philosophy.

2.1.2. Kaizen

Kaizen is a combination of two Japanese words, *kai* meaning *change* and *zen* meaning *better*, which together mean change for the better or also known as *continuous improvement*. It can be recognized as a characterization the Japanese philosophy, which focuses on continuous improvement processes through incremental changes based on constant learning (Herscovici, 2018).

The aim of the Kaizen was to collect and analyse data to identify the real problem and design some solutions; as well as start to break down functional barriers and general scepticism about Lean thinking (Melton, 2005). Often Kaizen can be mistaken for Lean Manufacturing or that they are the same thing, that can be clarified with the authors S. Kumar et al. (2018) statement which encourages the use of the two concepts as a whole concept towards the same goal, continuous elimination of waste through small improvements, by installing a secure and reliable methodology to achieve efficient processes.

2.1.3. Waste

In terms of production processes, waste can be defined as any action that needs resources to be done and does not add value to the product (Herscovici, 2018). In order to improve efficiency and be more competitive, businesses should eliminate Muda, a Japanese word for futile, which will also help reduce costs. (Singh et al., 2009). If the Muda control is done at an early stage huge savings can be gained (Melton, 2005).

According to Hines and Rich (1997), there are seven types of waste seen from the perspective point of Lean Manufacturing: 1. Overproduction; 2.Transport; 3.Stock; 4. Motion; 5. Waiting; 6. Over-processing; 7. Defects; and there is one extra that has been lately added being 8. People´s time. Being lean therefore implies a continuous effort to achieve a state characterized by minimal waste and maximal flow. It is essential to learn to view waste through “fresh eyes,” continuously increasing awareness of what constitutes waste and working to eliminate it. (Tapping et al., 2003).

2.2. Lean Tools

Lean tools and techniques are good industrial engineering practices that can be applied to companies in many contexts and without a lot of difficulties (Shah & Ward, 2007). They are used to accomplish what lean manufacturing stands

for: waste elimination, cost reduction, improved quality and decrease in the lead time, inventory and equipment downtime (Chen et al., 2010).

2.2.1.Value Stream Map

VSM is defined as a powerful tool that not only highlights process inefficiencies, transactional and communication mismatches but also guides improvement towards cleaner processes (Rother & Shook, 1999).

It consists of mapping the process flow of information and material from the moment it is decided to implement this new tool, also known as the current VSM, followed by a critical analysis of the gathered information and identifying waste to mitigate with Lean principles. Later on, it is mapped the future state map, the situation where the organization aims to reach with the proposed improvements (Womack & Jones, 2003).

It is important to include everything, the non-value added and value-added activities so as to provide a clear view of what elements of the process are working towards generating value and which are not (Tapping et al., 2003).

How to generate a VSM? Starting from the customer delivery endpoint and working back through the entire process documenting the process graphically with specific symbology, and collecting data (activities time, waiting time, number of workers, etc.) along the way until reaching the suppliers. It results in a single page map containing data, such as cycle time, work-in-process (WIP) levels and also the flow of information within the system (Singh, 2009). The steps taken in Value Stream Mapping are described as follows (Lasa, I.S. et al., 2008):

1. Select the product or product family you want to map;
2. Draw the current state value stream map, so that waste can be identified;
3. Draw the future state value stream map, using demand, flow and levelling concepts and other lean tools;
4. Create a work action plan;
5. Implement the action plan;
6. Achieve the action plan.

It is important to remark that VSM is a proven process for planning the improvements that will allow the company to operate under Lean methodologies in the best way possible. Being the key ingredient in this recipe the involvement of people throughout the process, from production plant operators to office employees including the high management (Tapping et al., 2003).

2.2.2. Root Cause Analysis

The CED was designed to sort the potential causes of a problem while organizing the causal relationships by Professor Kaoru Ishikawa in 1943. CEDs are drawn primarily to illustrate the possible causes of a particular problem by sorting and relating them using a classification schema (Doggett, 2005). It encourages data collection by highlighting areas of expertise or by showing where knowledge is lacking.

Overall, the advantage of the CED is that it is easy to use, it promotes structure while allowing some creativity, and it works best when the problem is well defined and data-driven (Mahto et al., 2008).

2.2.3. 5S & PDCA

The 5S methodology is a management technique that allows controlling of the production plant by means of a visual tool for maintenance and cleanliness of the workplace (Melton, 2005). It is defined by 5 Japanese terms beginning with the letter S and can be translated into English as follows (Womack & Jones, 2003):

i. Seiri (Sort) – Select and classify the items to be kept and discard those that are not used;
ii. Seiton (Straighten or orderliness) – Each item should go in a certain place so that it is easy to find, use and replace it;
iii. Seiso (Shine or cleanliness) – Identify abnormal conditions that could change production quality or lead to machinery failures;
iv. Seiketsu (Standardise or create rules) – Develop standardized procedures for maintaining the first 3's.
v. Shitsuke (Sustain or self-discipline) – Standardized methodologies are a continuous process of improvement.

In the beginning, this methodology focused on product quality. After years of development, the benefits started to change. It started to be a way of saving resources, helping to reduce storage costs and production time (Caliskan, 2016). All of these aspects improve productivity and safety for employees (Ohno, 1988).

The PDCA cycle is a systematic method for problem-solving to generate continuous quality improvement. This significant tool was created by Edward Deming and can be used to structure the 5s methodology mentioned above. It is composed of 4 repetitive steps that begin by

facing the problem and end in its resolution. The four stages are (Deming, 1993): 1. Plan; 2. Do; 3. Check; 4. Act.

2.2.4. Work Standardization

Standard Work is a listed description of each work activity in the process specifying: cycle time; TAKT time; the work sequence of specific tasks; and the minimum inventory of parts on hand needed to conduct the activity (Womack & Jones, 2003). In the analysis of the activities in the value stream, steps can be reduced, eliminated, and/or combined to ensure that the cycle time for the process is as efficient as possible. Adding to the information required mentioned before it can also be needed to create the routine sheet, where it is registered the time it takes a worker to walk between processes, machine processing times, and manual operation times.

Standardized work provides a basis for consistently high levels of productivity, quality, and safety. Standards are established to reduce variation in any and all forms. As it is drawn the future-state VSM, it is not actually developed a standardized work chart in that instance, it occurs during the implementation process. However, the future-state map should always show exactly where standardized work is to be implemented (Tapping, D. et al., 2003).

2.2.5. Stock Management

To implement any kind of improvement regarding material flow it is important to have available, clear and suitable information to work with regarding material handling. There are many systems to organize and treat supplies, such as the Pareto principle, but to find the most suitable system for stock management, it is important to understand that demand can be characterized by three criteria, as dependent or independent, uniform or non-uniform and deterministic or stochastic. Demand can not only be determined by the customer demand but for the requirements of materials that occur in between production sectors. It is very important to keep track of this information and the availability of it to specific departments (Kaya, 2017).

Nowadays, there are a large number of organizations using hybrid models that include customized Material Requirements Planning (MRP) systems, Just-in-Time (JIT) techniques such as Kanban's and Theory of Constraint techniques when classical stock management policies are still being used. JIT techniques and the use of Kanban incorporate a set of Lean tools for stock management (Guide Jr., 2000).

Looking at MRP's basic philosophy, the organization should be able to focus the scheduling to only for materials that are needed and when they are needed. MRP allows greater flexibility in product customization (Plenert, 1999). To achieve this goals the MRP should succeed in this three main aspects:

- To combine information on demand for final products (independent demand) with information on the structure of these products, the required quantities of the dependent demand items do not have to be forecast (reduction of uncertainty).
- To integrate inventory management information, the net requirements for demand-dependent and demand-independent items can be obtained, and only these requirements need to be ordered.
- To enter information on lead time for purchased items and for produced items, also information of the purchase orders from clients and define production orders in periods of time that ensure delivery when the items are required.

Even though MRP was not specifically designed to have labour based routings and a labour based production order tracking system, it almost always does. Because of this, through its usage rather than through its design, MRP has become a workforce-production efficiency oriented system, where production lead times are used to build buffer inventories in front of workstations so that workforce efficiencies can be maximised (Plenert, G., 1999).

2.2.6. SMED

A number of rules must be taken into account when a setup operation is performed in order to accelerate the process (Mileham et al., 1999). SMED establishes an efficient and quick way to change the product, which is manufactured in a production process (Ulutas, 2011). Any operation that can be analysed with SMED tool should be divided into two parts: first the internal setup, which is formed by the setup activities that can only be carried out once the machinery is stopped; second the external setup, which is formed by the setup activities that are to be carried out when the machinery is operating. SMED's purpose is to decrease product production times, optimise machine utilisation and reduce batches' size.

2.3. Lean Benefits

Lean Methodologies impacts have been known to be difficult to measure or attribute to a specific task improvement, but throughout surveys conveyed to manufacturing companies it is found that leading a company with Lean principles breeds important benefits in the areas of operation, administration and management, with improvements of up to 90% reduction of time in the work cycle. Also affects the final quality of the product by increasing it by 80%, allowing it to gain market share against the competition. (Green et al., 2017). Hereunder is listed the typical benefits that Lean Manufacturing delivers in a very real and physical concept, that can be adopted for all aspects of the supply chain and should be if the maximum benefits within the organization to be sustainably comprehended (Melton, 2005):

- Less Process Waste
- Financial Savings
- Reduce Lead-Time
- Increased Process Understanding
- Reduced inventory
- Less Re-work

3. Case Study

3.1. R&A Indumentaria

R&A Indumentaria is a company founded in the year 2002 based in Buenos Aires, Argentina which main activity is developing products for the textile manufacturing industry. The company stands out with it constants efforts of create quality products and have a high level of compliance with customers. Since the year 2019, R&A faced a production expansion that led to an expansion of the plant. Since then, the board of directors has set out to improve the company's productivity in the face of these changes.

The plant has a building delimited in two distinguishable sectors, with 3 floors in each one, all aligned in the product supply chain. The production processes that take place can be identify in the following figure:

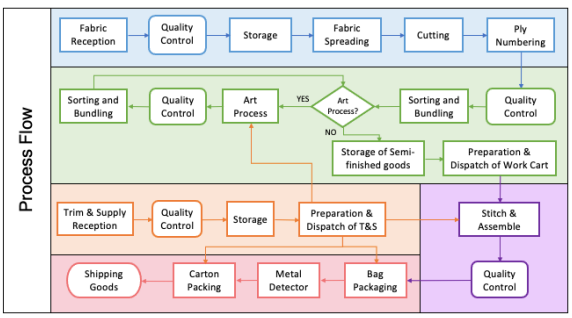

Figure 1 – Major process flow chart.

Raw materials and other materials are received in the reception area to enter and be stored in the relevant warehouses. From there they are transferred to the production area upon request of the sector. Firstly it is the fabric storage how starts the production order, as fabric is the base material for all the other processes. After being cut into the corresponding pieces, the garment can overcome an art process done internally or externally to be ready for the sewing line. Finally quality control takes place and approved items are packed in bags and boxes to be delivered into the clients distribution center.

3.2. Identification of problems

R&A's production planning is subjected to great variability due to product changes from the client as well as the shortage of supplies from the providers. One of the problems that this regular procedure entails is the need to manage good information between sectors and the availability of materials rapidly, in a clear way and accurately. As it is shown in figure 2 one of the storage for raw materials was found in poor order conditions. And also found that one family of raw materials, threads, which is stored as well in this deposit did not have any kind of inventory registration, control or defined space.

Figure 2 – T&A deposit disorganised and difficult to access.

It can be deduced that from these two reasons the inefficiencies and waste in the production sector become more noticeable, as can be seen in figure 3, where carts with semi-finished products are waiting to enter production due to a lack of raw materials.

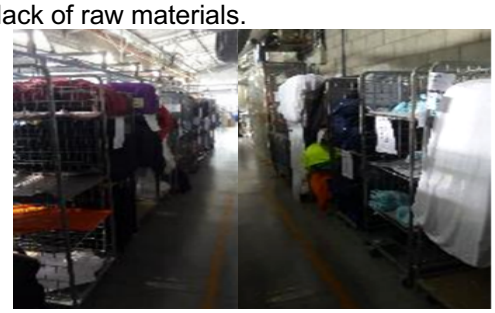

Figure 3 – Example of trolleys parked on production floors with started PO's that lack some component for producing a complete manufacturing garment.

Consequently, when the data on purchase orders and deliveries for the first half of 2021 was surveyed, it was found that the average delivery performance was 85%. It is noteworthy that in no month was it possible to deliver all orders on time.

4. Final Remarks and Future Work Development.

Following the literature review, a multi methodology composed of Lean tools and methodologies was developed for R&A Indumentaria to be develop in detail and applied seeking to generate productivity improvement regarding the problems stated.

4.1. How to start LM implementation

To be successful in the face of change, it is important to have an enabling methodology to make this happen. The following is a series of steps that are efficient for the application of Lean tools in an organization:

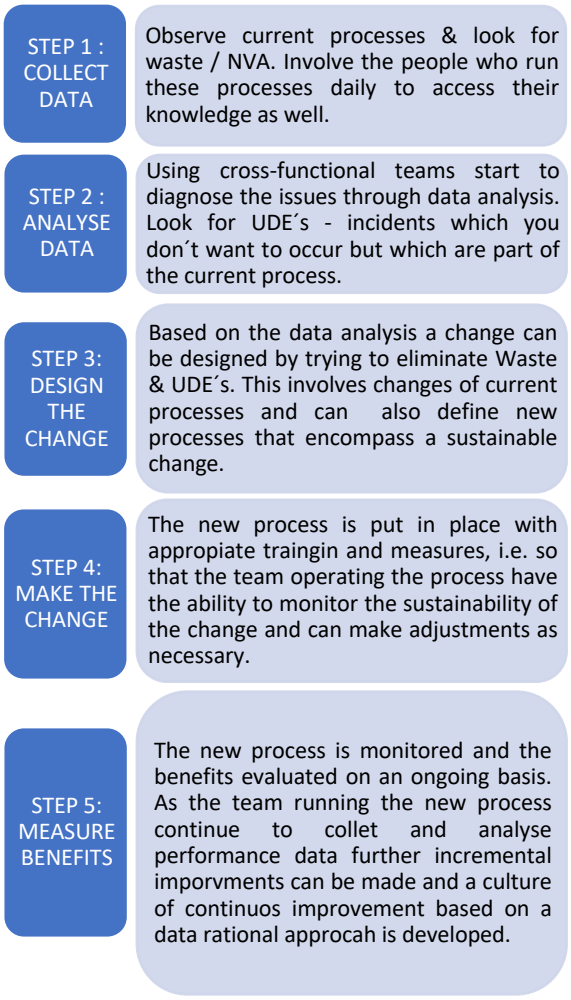

Figure 4 – How to “Lean Manufacture” – (Melton, 2005)

4.2. LM Tools implementation in R&A

The Lean Manufacturing tools chosen to be implemented in the company are in the first instance VSM and Root Cause Analysis, which, when applied together, provide a broader vision of the cause of the problems and their effects on the production processes. In a second instance it will be described the other LM methodologies that complement the mitigation of the found problems, being them the Kaizen Project – 5S and the Stock Management of threads.

4.2.1.VSM & CED

The current VSM for R&A Indumentaria was performed gathering information on the number of operators and material and informational flow. What can be perceived from the so-far developed mapping tool is that the communication arrows have a direct impact on different parts of the process so the first recommendation to mitigate the planning and resourcing problem will be to re-evaluate the production flow in order to generate a **pull system** with lean tools. Also there are some warnings signs that indicated visual inefficiencies that could be resolved with Kaizen methodology applied in all the company sectors.

The CED was introduced to have a better understanding of the problems incidence so that begin to applies when facing new problems.

4.2.2.Kaizen Project – 5S

The Kaizen project consists of a general immersion of the company in the concepts of Lean manufacturing and Kaizen methodologies in production processes. In conjunction with this, the use of the methodology expressed by Deming, PDCA, is proposed. The integration of the whole organization towards a Lean manufacturing philosophy requires engagement from the operatives until the high management. The first action of the Kaizen Project is to have a General Assembly of 5S understanding. This activity took place with one representative of each area and raised awareness of Lean manufacturing as well as Kaizen and the productive benefits that these concepts encompass. This meeting is a key starting point towards an organization with clear information flow, as well as creating awareness of the importance of eliminating different types of waste previously identified.

The second step will be the application of 5S in all the different workspaces. For this it will be carried out a focused training in the sector under examination, survey the area together with the operators and establish the necessary actions

for the correct implementation of the 5S. Afterwards, a maintenance plan will be left at the workplace for the employees of the sector to have a guideline with actions and time of reviewing them.
In the near future, the management team of the kaizen project will be in charge of conducting a 5S audit with a score in those sectors that have started with the implementation of this methodology. This will not only help to consolidate the knowledge provided but also demonstrates that it is a philosophy that the company aims to maintain and support continuous improvement.

4.2.3.Stock Management of threads

The threads sector was the first to be trained in the second step of the Kaizen project, which made it much easier to approach the tools used for the implementation of a thread stock management system. Firstly it was registered with a 7 wastes sheet during a month the wastes encountered that generated the problems showed before. Then, with the records, a Pareto diagram was drawn up to focus the action plan the most recurrent wastes. The outcome for this system was divided into the following steps:

1. Thread Management Spreadsheet
2. Carry out a comprehensive survey of the current stock
3. Dispose of threads that are no longer usable or in poor condition.
4. Dimension the available storage space
5. Documentation of the location of each type of thread.
6. Designate a person in charge of the sector to keep control of income and expenditure, as well as the order and cleanliness.

4.3. Final Conclusion

The **future vision** VSM map is still in development as the processes of analysis and their integration where complex to resolve in a short amount of period. Despite this fact it was established that it should be drawn in order to be **end-to-end pull system based**, creating flow between operations. To reach such vision, all improvement activities should be identified and prioritized, leaning to implement first the easy targeted tools, re-analyzing the hole process and the continue with the remaining waste elimination. Some of the previously mentioned tools that where considerate to future work development where application of SMED for the packaging sector and the implementation of an MRP system.

The combination of the VSM tool with the implementation of the Kaizen philosophy generates a significant improvement in the other issue exposed, inventory management, by supplying information at the time of use, increasing the transparency of processes and promoting management through data and facts.

Regarding the Stock Management of thread system proposal, Once this action plan has been carried out over a sufficiently long period of time (12 months minimum), the company will have substantial information of a material that previously did not have and that was contributing to hidden costs due to disuse and space usage. This will also gain operational efficiencies in the sector.

In conclusion, the implementation of Lean Manufacturing developed in this paper is a project for continuous improvement of the organisation and processes for R&A specifically context. As a future challenge the company must find sustainability of these tools by demonstrating throughout the organization the support from top management to improve the results of the performance indicators.

5. References

Bicheno, J., Holweg, M. (2009). The lean toolbox: The essential guide to lean transformation, *Picsie Books.*

Caliskan, N. (2016) "Benefits of Lean Office," *European Journal of Business, Economics and Accountancy*, 4(6). Available at: www.idpublications.org.

Chen, J. C., Li, Y., Shady, B. D. (2010). From value stream mapping toward a lean/sigma continuous improvement process: an industrial case study. International Journal of Production Research, 48(4), 1069–1086.

Chiang, C., and Gutierrez, G.J. (1996). Theory and Methodology: A Periodic Review Inventory System with Two Supply Modes. *European Journal Of Operational Research*. Vol. 94, 527-547.

Deming, W. E. (1993) The new economic for industry, government, education, *MIT Center for Advanced Engineering Studies,* Cambridge, MA.

Doggett, A. M. (2005). Root Cause Analysis: A Framework for Tool Selection. *Quality Management Journal* 12 (4): 34–45. https://doi.org/10.1080/10686967.2005.11919269.

González , F. (2007). Manufactura Esbelta (Lean Manufacturing). Principales Herramientas. Obtained from a web document: http://www.itcelaya.edu.mx/ojs/index.php/raites/article/view/7 7

Green, J., Lee, J., Kozman, T. (2010). Managing lean manufacturing in material handling operations, *International Journal of Production Research*, 48 (10), 2975-2993, 2010.

Guide Jr., D.V.R (2000). Production Planning and Control for Remanufacturing: Industry Practice and Research Needs. *Journal of Operations Management*. Vol. 18.

Herscovici, A. (2018). New development: Lean Thinking in smart cities. *Public Money & Management,* 38(4), 320–324. https://doi.org/10.1080/09540962.2018.1450924, (Accessed: December 4, 2022).

Hines, P., Rich, N. (1997), The seven value stream mapping tools*, International Journal of Operations & Production Management*, Vol., Vol. 17.

Hines, P., Rich, N., Bicheno, J., Brunt, D., Taylor, D., Butterworth, C., Sullivan, J. (1998), Value stream management, *The International Journal of Logistics Management*, Vol. 9 No. 1, pp. 25-42.

Hines, P., Holweg, M., Rich, N. (2004). Learning to Evolve: A Review of Contemporary Lean Thinking. International Journal of Operations & Production Management, 24(10), 994–1011.

Hofer, C., Eroglu, C., Hofer, A. R. (2013). The effect of lean production on financial performance: The mediating role of inventory leanness. *International Journal of Production Economics*, 138(2), 242–253.

Holweg, M. (2007) The genealogy of lean production, *Journal of Operations Management*, 25(2), pp. 420–437. doi:10.1016/J.JOM.2006.04.001.

Imai, M. (2012). Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy (2nd Edition). McGraw Hill.

Kaya, O., Polat, A.L. (2017). Coordinated Pricing and Inventory Decisions for Perishable Products. *OR Spectrum* 39 (2): 589–606. https://doi.org/10.1007/s00291-016-0467-6.

Kumar, B. S., Dhingra, A. K., Singh, B. (2018). Process improvement through Lean-Kaizen using value stream map: a case study in India. *The International Journal of Advanced Manufacturing Technology*, 96, 2687–2698. https://doi.org/10.1007/s00170-018-1684-8, (Accessed: November 22, 2021).

Lasa, I.S., Laburu, C.O. and de Castro, V.R. (2008), An evaluation of the value stream mapping tool, *Business Process Management Journal*, Vol. 14 No. 1, pp. 39-52.

Mahto, D. and Kumar, A. (2008) "Application of root cause analysis in improvement of product quality and productivity," *Journal of Industrial Engineering and Management*, 1(2), pp. 16–53. doi:10.3926/jiem.2008.v1n2.p16-53.

Melton, T. (2005). What Lean Thinking has to Offer the Process Industries. Chemical Engineering Research and Design, (83(A6)), 662–673.

Mileham, A. R., Culley, S. J., Owen, G. W., McIntosh, R. I. (1999). Rapid changeover-a pre-requisite for responsive manufacture. *International Journal of Operations & Production Management*, 19(8), 785–796.

Ohno, T. (1988) Toyota production system: Beyond large-scale production. *Cambridge, MA: Productivity Press Paul A. Myerson, McGraw-Hill (2012) "Lean Supply Chain & Logistics Management"* 215-316.

Plenert, G. (1999). Focusing material requirements planning (MRP) towards performance. *European Journal of Operational Research, 119(1), 91–99.* doi:10.1016/s0377-2217(98)00339-7

Rother, M., Shook, J., (1999). Learning to See: Value Stream Mapping to Add Value and Eliminate Muda. *The Lean Enterprise Institute,* Inc., Brookline, MA

Shah, D., Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of Operations Management,* 25(4), 785–805.

Singh, B., Sharma, S. K. (2009). Value stream mapping as a versatile tool for lean implementation: an Indian case study of a manufacturing firm *Measuring Business Excellence*.

Tapping, D., Shuker, T. (2003). Value Stream Management for the Lean Office*. New York*: Productivity Press

Ulutas, B. (2011). An application of SMED Methodology. *World Academy of science, engineering and technology*, 79, 101.

Womack, J.P., Jones, D.T. (1994). From lean production to lean enterprise ,*Harvard Business Review*, pp. 93-103.

Womack, J.P., Jones, D.T. (2003). Lean Thinking: Banish Waste and Create Wealth in Your Corporation. *Simon and Schuster*.

Womack, J.P., Jones, D.T., Roos, D. (1990). The Machine that Changed the World: The Story of Lean Production, *HarperCollins Publishers.*