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A Review of Literature on Lean Manufacturing Tools and Implementation Based on Case Studies

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Abstract. This research focuses on reviewing the Lean Manufacturing (LM) implementation which is widely applied in the manufacture company to overcome or reduce waste. The aim of this article is to find out more about the influence on the industry sector. This research was developed by collecting research from indexed databanks of Scopus, Science direct, ResearchGate, etc. This review study is significant to identify the application of lean manufacturing in dealing with waste through implementation into several case studies. A total of 24 articles were selected, taking into account criteria such as keywords, article titles and publications of international publishers, which were selected through a systematic process. This study found that the application of lean manufacturing is a method that brings many advantages that work by minimizing losses and waste, and the Value Stream Mapping method is more often used as part of several Lean Manufacturing techniques to identify and analyze the occurrence of waste while providing solutions that lead to improvement. process and cost reduction.

Keyword: Continuous Improvement, Lean Manufacturing, Literature Review, Manufacturing, Waste

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1. The Introduction

In a highly competitive context, companies try to minimize costs to operate at higher margins and, at the same time, proposes the customer better value for money [1]. For this reason, in the field of production, so-called lean manufacturing or also called lean manufacturing has been developed [2]. To successfully implement a lean manufacturing strategy, it is important to act to avoid the waste of overproduction (excessive production), inventory (inventory), defects (defects/damage), transportation (moving/transportation), motion (movement), waiting, over processing, and skill (Ability) [3].

In order to reduce production times, it is essential that information circulate quickly and correctly among all the agents that participate in the production process [4]. In the same way, those

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responsible for each section must agree on strategies and control the correct implementation in their plot [5].

The company produces according to what the potential public demands. In this way, it is avoided to produce more than what is necessary and the cost of the materials to be procured is minimized [6]. Since the processes are not fixed, in case there is any kind of change in customer preferences, adaptability to the new process is fast [7].

The main risk of producing according to demand is suffering some type of stock out and not being able to offer the product to the customer within the agreed period [8]. To minimize this risk, it is important to agree long-term and stable relationships with suppliers that have shown the ability to also adapt to possible changing demand [9].

This research is organized as follows: First, a theory framework was discussed. Second, methodology was presented. Third, present the outcomes and discussions, and finally summary was applied. Furthermore, this literature review builds an inclusive view of LM applied in manufacture industry, and also critically reviews previous research using a systematic literature review method.

This work distinguish some of LM method to solve several cases of waste that occur in the manufacturing industry, in particular waste that can be detrimental to the company, because it can lead to a lack of effectiveness and efficiency, the use of raw materials that exceed the standard capacity, excess of production goods or not adjusting the number of orders from customers, waste which causes a decrease in company profitability, waste of movement of machines and workers which reduces the efficiency of production time, and lack of production materials, which causes workers to be unable to produce goods as usual.

2. Theoretical Basis

2.1. Concept of LM

LM is a production management approach that emphases on maximizing added value and minimizing waste [10]. This approach is based on the idea that excess inventory, overproduction, unnecessary movement, waiting time and other types of waste are not only inefficient, but can also reduce final product quality and enhance cost. This work philosophy originated in the Toyota automotive company in Japan, where a production system called "Toyota Production System" (TPS) was developed [11]. This TPS is based on the continuous elimination of waste, continuous improvement and customer satisfaction. Since then, the lean manufacturing approach has been adapted and used in a wide variety of industries around the world [12].

Something important to keep in mind that manufacturing need a transformation in the way production is thought of and managed. Instead of focusing on increasing production and reducing costs through economies of scale, it seeks to maximize added value and minimize waste. This can

be achieved through a number of tools and techniques, such as the flow chart, visual tracking, error management, continuous improvement, and problem solving [13].

LM is a model focuses on creating flow in production to provide maximum value to customers, using minimum required resources and avoiding waste [14]. [15], [16], [17].

The lean manufacturing philosophy tries to optimize the production system and reduce or eliminate worthless task [18]. LM term appeared in the machine manuscript that changed the world (published in 1970's). The strategy of LM employment is known as "The 5S", a program developed by Toyota to achieve long-term improvements [19].

The lean manufacturing philosophy tries to optimize the production system and reduce or eliminate waste task [18]. The strategy of LM employment is known as "The 5S". Toyota develop LM program to achieve long-term improvements [19]. 5S defines the operation of this manufacturing model through 5 Japanese principles: Seiri: subordinate, classify, and discard; Seiton: systematize and order; Seiso: cleansing and cleaning; Seiketsu: simplify, standardize, and make coherent; Shitsuke: supports process and discipline [19]–[21]. LM to diminish cost losses and increase added value [9]. LM success to improve business competitiveness demonstrated that it is an essential value for the survival of organizations [16].

2.2. LM Tools

It is necessary to know the various LM tools used in production systems, as follows: [6], [11], [13], [14], [19].

1. TQM; increase production efficiency and optimize delivery times.
2. JIT; respecting this system will only produce on demand.
3. Kaizen; the system that ensures continuous improvement.
4. ToC; it is based on finding the bottleneck to set the production rate of the chain.
5. Andon; a management system that allows operators and managers to know the progress of the improvements and their application status.
6. Single-Minute Exchange of Die; purpose is to reduce the reference change time in machine tooling in production environments.
7. VSM; it is based on a diagram that allows visualizing, analyzing and improving the flow of production and information, from the beginning of the process to delivery to the customer.
8. Heijunka; a lean technique that reduces inequalities in a production process and minimizes the possibilities of overload
9. KPI; to measure the level of performance of a process
10. Kanban; information system in the workplace to define, manage and improve services.
11. Process re-engineering; pursue large-scale improvement by working on process redundancy.

2.3. Benefits and Advantages of LM

A. Benefits

Relying on LM brings lots of advantage for companies in the medium and long term [11], such as increase efficiency, the quality improvement, and sales or the value efficacy [15], [22].

One of its key principles is the so-called "value stream" [4], [13], [15], [21]. This principle refers to the idea that production should be organized in such a way that the product flows from one stage to another smoothly and without interruption [19], by eliminate extra inventory and reduce waiting times of the production process [20]. As we discussed at the beginning of the article, one of its main features is the elimination of waste. The idea is to find and abolish such as overproduction, excess inventory, unnecessary movements of materials, waiting times). The elimination of waste improves efficiency, the quality of the final product and reduces costs [17], [22].

In addition to eliminating waste, another key lean manufacturing tool is continuous improvement [19]. The idea is that it is not simply about implementing a production system at a given moment, but rather it is about a constant process of improvement and optimization [23]. This is achieved through the active participation of all team members, who work together to identify and solve problems, improve the value stream and increase efficiency [24].

B. Advantages

Reducing waste may be a key benefit in its own right, but pursuing LM yields a number of other secondary benefits [16], [19], [20], [23], [24]: (1) Increase efficiency frees employees to spend more time on innovation and quality control; (2) Better lead time; (3) Sustainability; and (4) Greater profits.

3. Methodology

This study presents the relevant literature of LM application in accordance with stated objectives. Literature reviews were obtained through various databases available from the Google Scholar search engine database, namely Web of Science, ResearchGate, and ProQuest which contain a large number of international publications such as IEEE, IOP, MDPI, Emerald, Springer, as well as international conference/seminar publications. The structured review methodology consists of five stages as shown in Figure 1. It should be explained in this section, although the number of publications identified during the screening process is quite large, it is not possible to analyze all articles. For this reason, the author focuses on lean manufacturing techniques which are widely applied to overcome or reduce waste. As a result, 24 articles with case studies were selected, reviewed, and further analyzed.

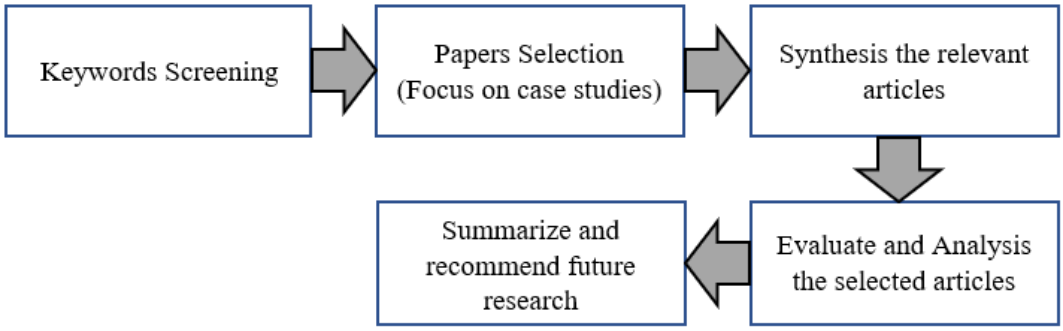

Figure 1 Phase of Literature Review Research

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4. Results and Discussions

Various previous paper work associate to the LM that fit the purpose of the research was selected for advance study, and among 24 articles had appraise for further investigation. Table 1 presents the previous research, publisher and year of the journal published.

Table 1 Previous Works in the Literature Review of LM and It's Practice

No.	Method	Publisher	Year
1	PLS-SEM	International Journal of Engineering Business Management	2023
2	ANN, K-Nearest Neighbors, Decision tree, Linear discriminant, Naive Bayes algorithms, Support Vector Machine, Ensemble machine learning models	MDPI	2023
3	Theory of Planned Behavior (TPB)	MDPI	2022
4	Toyota Production System	ResearchGate	2022
5	Kaizen	ResearchGate	2022
6	LM	BMIJ	2022
7	ERP	ResearchGate	2022
8	JIT, TQM, TPM.	IEEE	2022
9	Participatory Decision Making, Multiple regression analysis	ResearchGate	2021
10	VSM and OEE	IEOM	2021
11	Qliksense quality management system	Proceedings on Industrial Engineering and Operations Management	2021
12	Ergonomics	MDPI	2021
13	SEM	MDPI	2021
14	Blue Ocean Manufacturing	Elsevier	2021
15	Cronbacch Alpha	IOP	2019
16	PLS-SEM	Journal of Management Research and Emerging Sciences	2020
17	Value Chain	Elsevier	2019
18	Lean Six Sigma	ResearchGate	2019
19	Fuzzy Logic Based Quantitative Lean Indeks	Elsevier	2016
20	VSM	ResearchGate	2015

No.	Method	Publisher	Year
21	VSM	Jurnal Teknologi	2014
22	Wastes Relations Matrix (WRM)	International Journal EFMS	2013
23	Kanban	Elsevier	2013
24	VSM	Elsevier	2012

Research in work in table 1 above employ LM method, especially to overcome some of the problems in the manufacturing production process to prevent and eliminate waste so as to increase product-added value, such as Value Stream Mapping, Overall Equipment Effectiveness, Kanban, Fuzzy Logic, Lean Index, Kaizen, Automation, JIT, PLS-SEM, Wastes Relations Matrix, Ergonomic, Blue Ocean Manufacturing, LM Integrated, JIT, TQM, TPM, ERP, Theory of Planned Behavior, AME Lean Assessment, Artificial Neural Networks, MLK, Nearest Neighbors, Support Vector Machine, and Lean Six Sigma.

Table 2 Reviewed of LM Application

No.	Method	Authors/ Years
1	VSM	AR Rahani et al (2012), Zahraee S.M et al., (2014), Nallusamy, S et al., (2016), Jimene G et al., (2019)
2	VSM and Overall Equipment Effectiveness	Moghadam M et al., (2021)
3	Kanban	Rahman N.A.A et al., (2013), Masemola M.K et al., (2020)
4	Fuzzy Logic, Lean Index	Oleghe O et al., (2016)
5	Kaizen, Jidoka, JIT,	Naeem M et al., (2021)
6	Kaizen	Fazli M et al., (2022)
7	PLS-SEM	Abu G et al., (2021), Adzrie M et al., (2020), Panigrahi S et al., (2023)
8	Wastes Relations Matrix	Khalil A et al., (2013)
9	Ergonomic	Colim A et al., (2021)
10	Blue Ocean Manufacturing	Sadiq S et al., (2021)
11	LM Integrated	Angın N et al., (2022)
12	JIT, TQM, TPM, ERP	Saleem G (2022)
13	JIT, TQM, TPM	Jayawardane K et al., (2022)
14	JIT	Hameed W.U et al., (2020)
15	Theory of Planned Behavior (TPB)	Lai N.Y.G et al., (2022)
16	AME Lean Assessment	Rodrigues W et al., (2022)
17	ANN, Machine Learning, K-Nearest, and Support Vector Machine	Sekhar R et al., (2023)
18	Lean Six Sigma	Gazizulina et al., (2019)

Table 3 shows the categorization of the literature review by consider the aspects of the paper. The first aspect is the year of publication. In this study, the papers obtained were published from 2012 to 2023. The second aspect is the focus of applying Lean Manufacturing techniques to case studies. The third aspect is the finding or contribution to solving the problems raised.

Table 3 Survey of LM Contribution

No.	Authors	Research Focused in	Major Findings
1	[17]	This research uses a case-based approach to determine how LM help eliminate waste of an Automotive part manufacturing, retain inventory control, enhance the product quality, and exercise more operational control	Quantitative evidence shows that many Lean tools have the desired impact associated with reducing this waiting time. Evaluation of these repairs using CT evaluations highlights the economic impact of repairs over time. VSM is applied to assess the expected impact of changes in the production

No.	Authors	Research Focused in	Major Findings
		either by adopting VSM, SMC techniques	process resulting in savings (lower rejection rates) and to some extent, the positive view is due to a substantial gap between standard work and real work – this gap means that workers are not following standards rigorous assembly and improvisation of SOPs can be key drivers in continuous improvement on the production floor as operators are fully aware of the long-term commitment to practicing Lean.
2	[10]	This research investigated the elimination of waste in manufacturing companies in the Gaza Strip and its important role in reducing production costs using the Wastes Relations Matrix (WRM) method.	A WRM technique positively reduces the manufacturing business production cost
3	[11]	This study determined Kanban works successfully in Malaysian manufacturing company) to characterize factors that hinder Malaysian SMEs by adopting Kanban techniques.	The present study posited that the elements contributing to the effective adoption of the Kanban methodology include inventory management, vendor and supplier participation, quality improvement and control, employee dedication, and top management support.
4	[24]	This study aims to VSM to improve the production lines of companies producing multiple components for vehicle assembly lines by reducing waste and non-value-added activities.	Green Lean infrastructure systems provide a conduit for the successful implementation of lean green best practices and achievement of the corresponding eco-friendly results, and it is found that there is enormous scope for the application of the Lean Green Methodology in small-scale industries.
5	[14]	This study developed a green lean approach in the small-scale construction industry in Tamilnadu, India by using the Value Stream Mapping (VSM) technique which has been modified in this study.	Green Lean infrastructure systems provide a conduit for the successful implementation of lean green best practices and achievement of the corresponding eco-friendly results, and it is found that there is enormous scope for the application of the Lean Green Methodology in small-scale industries
6	[13]	This study applied a quantitative Lean Index based on fuzzy logic to manufacturing situations using simulated data, showing variability modelling as a superior approach to the deterministic method used to describe lean performance.	This study claimed that the Fuzzy Logic representation method interprets real events in the system, making it more powerful than conventional methods. This study also argued that Lean Index allows the calculation of the coefficient of variation, Cv so that the degree of variation can be classified as high (bad) or low (good), and Modeling the variation of the lean index makes the lean index a good candidate. for Monte Carlo Simulation, thereby enhancing Lean Index capabilities.
7	[4]	Diagnoses production process situations in the Fish and Shellfish Company's processing and marketing value chain as a case study, and focused on improving productivity and quality in the food industry value chain through lean manufacturing methodologies	This study characterizes the current state of the process, taking the fresh fish line as a reference point, to identify tasks that add no value to the process, which represent 37.7% of processing time and correspond to work-in-process inventory, and over-movement due to deficiencies in plant distribution. and jams that start during the cutting process
8	[23]	The paper presented various LM features to improve sustainable business processes through a case study of the water pump housing	Lean Six sigma helps turns out to find ways to solve problems without substantial financial investments. Further, the economic effect amounted to 5612,90 $. The payback period for the implementation of changes is 2 months
9	[12]	The goal is to comprehend the overall viewpoint of Kota Kinabalu, Sabah-based industrial enterprises with regard to the application of specific lean manufacturing tools. This essay's objective is to assess how manufacturing organizations are implementing lean manufacturing and its resources.	Concluded that the method can be beneficial for companies participating in this study, especially companies that have not yet implemented lean tools. The study also claims their research is very useful for other researchers, as it collects data from lean and non-lean facilities in the real world, which allows evaluation of the effectiveness and direction in implementing LM.

No.	Authors	Research Focused in	Major Findings
10	[20]	Investigates the role of lean manufacturing in the financial performance of the Malaysian automotive industry by adopted the Just in Time (JIT) and PLS-SEM technique.	This study revealed that lean manufacturing and financial performance have a positive relationship with JIT, employee engagement, and quality management, and improve quality management, improved JIT and employee engagement improve a quality management which in turn improves Financial Performance.
11	[21]	Analyze how Lean Manufacturing techniques are applied in a South African manufacturing setting.	This research has identified defects, inventory, transportation, waiting, and people's ideas that are unused because they all impact company performance. Transport, damage, and inventory waste were found to have high primary interaction effects with the paint line, anti-intrusion box line, and bogie fixing line being some of the areas heavily affected.
12	[9]	Analyzing assembly line collaborative robot workstations performed by workers with musculoskeletal complaints using Human-Robot Collaboration integrated LM, and Ergonomics.	The integration of Human–Robot Collaboration, LM, and Ergonomics success improve the manufacturing processes. The integration of this method focuses on the development and implementation the industry of 4.0 environment.
13	[15]	Analyzed LM in the wood and furniture industries.	Revealed that LM to issues of knowledge, culture and human behavior, especially in companies with inadequate resources.
14	[16]	This research aim to develop an integrated framework that combines Lean Manufacturing (LM) with Blue Ocean Manufacturing (BOM) which is implemented on a production line of an automotive parts manufacturing industry using a longitudinal case study approach.	This study claimed that the concept of lean manufacturing and blue ocean manufacturing, greenhouse gas emissions reduced by more than 50%. This proves that blue ocean manufacturing can act as a powerful lever in improving the environmental performance of manufacturing systems.
15	[22]	Investigates the suitability of auto parts manufacturers from the Iranian auto industry using Value Stream Mapping (VSM) and Overall Equipment Effectiveness (OEE)	The combination of Value Stream Mapping (VSM) and Overall Equipment Effectiveness (OEE) can identify the overall speed of the production line has decreased due to the limited production machine capacity. There are two bottlenecks on the production line. This bottleneck includes process heating and inspection stations. The low speed of operators working in the heating process station causes delays in the whole process.
16	[19]	Adopts Kaizen technique to determine the impact of lean manufacturing practices in 122 textile firms in Pakistan on their operational efficiency.	The implementation of Kaizen, Automation (Jidoka), Just in time (JIT) has a significant impact on the operational performance of textile companies, it also shows that the involvement of customers, suppliers and employees leads to an increase in the company's operational performance
17	[8]	Examines the degree of LM knowledge, awareness, and integration maturity in one of the largest furniture manufacturer clusters. It also uses twenty-one Lean Manufacturing tools to determine the extent of LM's unrealized potential and areas of exploitation for the Bursa, Turkey, furniture industry.	Finding shows that members of the furniture industry Inegol, Bursa, and Turkiy varied in their level of understanding and integration of lean manufacturing regardless of firm size and their overall level of maturity of integration fell far short of desirable. In addition, this study also concluded that lean manufacturing is a versatile modern management technique that can be applied in any industry.
18	[7]	Attempts to discover the effects of lean manufacturing on organizational performance with respect to the mediation function of ERP, and also highlights how ERP plays a mediating role in explaining how lean manufacturing practices affect organizational performance.	ERP has a moderating influence on JIT and organizational performance, TQM and operational performance, TPM and operational performance, including the business financial performance
19	[6]	Uses an addiction index model to highlight the multifaceted nature of lean manufacturing employing JIT, TQM, and TPM techniques. It also seeks to critically assess the effect of	Performance in terms of inventory turnover is positively correlated with JIT, TQM, and TPM. Additionally, the performance of inventory turnover in the Colombo district's garment industry

No.	Authors	Research Focused in	Major Findings
		lean manufacturing strategies on the industry's inventory turnover performance in Colombo.	is shown to be significantly impacted by lean manufacturing strategies by this study.
20	[5]	Implementing the Theory of Planned Behaviour (TPB) to investigate the learning objectives of production employees in the southern region of Malaysia that manufactures automobile components.	According to Lai N.Y.G. et al., participants in lean training programmes are motivated to learn from training provided they have great positive attitudes and perceived behavioural control. Their study also supports the sequence of linkages outlined in the TPB model. Additionally, this study made the case that PBC and AT significantly influence participants' learning objectives in the lean manufacturing training programme.
22	[3]	Investigates the impact and the effectiveness of kaizen and product defection in 40 packaging companies in Selangor Malaysia. This research was also evaluated the effectiveness of lean manufacturing tools to improve Kaizen quality standards.	This research summarized that there was a significant positive relationship between 4M (Material, Process, Machine, Man), 5S (Shine, Sort, Standardize, Sustain, and Set in Order), PDCA (Plan, Do, Check, and Act), and Fishbone Diagram concepts due to product defects to quality standard Kaizen.
23	[2]	Utilize a machine learning technique to create lean manufacturing soft sensors that are helpful in classifying the accomplishments of 46 lean automotive parts manufacturing companies in the Pune, Maharashtra State, India, based on their current manufacturing flexibility.	According to this study, a three-layer neural network design may reach an 80% test prediction accuracy.
24	[1]	Investigate LM effect of 185 manufacturing companies in Oman City.	Argued that LM can explain operational performance, but cannot benefit overall business performance.

5. Conclusion

The objective set out in this article focuses on determining how the implementation of the Lean manufacturing method improves production capacity in manufacturing industries. Table 3 summarized LM help to specify the results obtained, leading to the effective and efficient use of processes, achieving the continuous improvement and optimization of resources making companies competitive. The LM implementation brings many advantages, for instance, the saving of losses produced in any type of manufacturing process. Likewise, it brings many methods within LM that can improve productivity such as a pull system, flow mapping, value identification, creating flow, and continuous improvement.

Several articles are referred to regarding LM and its techniques, applied in several case studies such as the manufacturing industry, and have been reviewed in this study. This study concludes from this literature review for various lean tools applicable in different industries as per requirement but value stream mapping technique is more used for waste detection and process improvement.

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