Lean implementation framework in luxury-fashion industry: a systematic literature review

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Abstract: In the contemporary landscape of manufacturing, lean practices have become renowned for their waste-reduction capabilities. Recently, lean manufacturing has become popular among scholars for its consistent sustainable impact and among practitioners for the eco-efficiency benefits brought to manufacturing companies, especially those where sustainability has been always a crucial matter. The luxury-fashion sector, known for its distinctive low-volume, high-variety production characteristics, has been always in the spotlight for lower attention towards sustainable practices. Because of that, this specific industry emerges as an environment where lean principles can play a pivotal role. This research aims to elucidate the optimal implementation of lean practices within the luxury clothing industry production process. Leveraging insights from existing literature on lean implementation frameworks in manufacturing and within the context of luxury-fashion, the goal is to provide a systematic approach tailored to the unique demands of this industry. The significance of this work lies in its potential to systematically expand lean implementation within the luxury clothing sector, offering a structured pathway to achieve the intrinsic sustainability benefits of lean principles. Through a comprehensive methodology employing a systematic literature review, this research identifies and evaluates existing knowledge in the manufacturing context, with a specific focus on the fashion clothing domain. The results of this study encompass the identification of the most effective framework for lean implementation in the luxury-fashion industry.

Keywords: Literature review, lean practices, lean implementation, luxury-fashion, clothing.

1.Introduction

The fashion industry is currently at a crossroads, with sustainability emerging as a paramount concern amidst escalating environmental challenges. The global fashion industry itself account for the 8% of the world's carbon emissions (OECD International Energy Agency, 2021).

Luxury fashion production is characterized by distinct challenges, including the rapidity of the fashion cycle leading to obsolete materials and unsold products, which significantly impacts profitability. To address this, the industry aims to reduce lot sizes, cut lead times, and increase flexibility. Additionally, luxury fashion deals with a lengthy and extensive inbound supply chain, high demand variability, extensive product customization, short product life cycles, and a high-quality rate. These factors contribute to market complexity, demand seasonality, and a multitude of product variants. Moreover, the luxury fashion sector contends with prolonged production lead times, necessitating anticipatory measures to align manufacturing activities with market launches. Furthermore, the craftsmanship inherent in luxury production, while ensuring high quality, introduces complexities in standardizing manufacturing processes due to the artisanal nature of workmanship (Carmignani et al., 2015).

Additionally, the characteristics of the luxury industry, such as high customization, craftsmanship, and the need to sustain premium pricing, align well with the solutions offered by lean practices. Lean management is renowned for sustaining product quality, ensuring consistent high-quality products through defect minimization and optimized production flows (Womack and Jones, 1996). Moreover, the emphasis on high customization in luxury fashion resonates with lean principles, particularly in low volume, high variety (LVHV) production environments. Case studies demonstrate the efficacy of lean layout planning in solving layout design challenges for LVHV companies (Cantini et al., 2013). The implementation of lean in such contexts would offer solutions to problems such as lack of free space, quality checks, high storage times, and time-consuming product transfers. Shah et al. highlighted the need for a systematic approach for the implementation of these practices in this industry to exploit their benefits (Shah et al., 2016). Lean practices inherently align with sustainability objectives by reducing resource consumption, minimizing environmental impact, and promoting efficiency (Ferrazzi et al., 2024). By optimizing processes and minimizing waste, luxury fashion companies can achieve significant improvements in sustainability metrics, such as reduced carbon emissions and resource usage. Thus, our research question (RQ) guiding investigation is the following:

RQ: What is the best framework for implementing lean principles in the context of luxury fashion manufacturing?

Indeed, our research seeks to explore existing literature on implementation of lean manufacturing tools across manufacturing sectors with the final objective of identify frameworks that align with the specific needs of luxury fashion industries. Through this systematic review, we endeavour to discern the most suitable approach for integrating lean principles into luxury clothing manufacturing, considering its intricate supply chain dynamics, demand variability, and craftsmanship imperatives. In this way, our paper can offer a possibility to practitioners to enhance highly requested sustainability in this manufacturing companies thanks to the implementation of lean manufacturing principles and to find the best approach for doing it. Doing so, they can succeed on enhancing operational and sustainability efficiency while maintaining their commitment to artisanal craftsmanship and product quality.

The paper is divided in 4 sections. It starts from the introduction with an overview of the context and an outline of the research objective and RQ. It is followed by the methodology with the explanation of how the study is conducted throughout a systematic literature review, and a section dedicated to the results obtained with the related comments. Finally, it ends with a summary of the results obtained and answer to the RQ, encountered limitations and thoughts for future research.

2. Methodology

To address the research question regarding the most suitable framework for implementing lean principles in the luxury fashion manufacturing context, we conducted a systematic literature review following the guidelines outlined by Tranfield et al.. This approach consisted of three main phases: planning the review, conducting the review, and reporting and dissemination (Tranfield et al., 2003).

The search for articles was conducted through the Scopus database. Scopus was selected as the sole database for its comprehensive coverage of authoritative and certified contributions from various journals in the research field (Pranckuté, 2021). The search string used for searching in Scopus underwent several refinements and iterative tests to ensure both completeness and specificity in retrieving relevant literature. We employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram to facilitate transparent reporting and synthesis of the findings. The PRISMA diagram serves as a reporting guideline that reflects advances in methods to identify, select, appraise, and synthesize studies, providing a structured overview of the study selection process (Liberati et al, 2009).

By adhering to this systematic approach, we aimed to ensure rigor and transparency in our review process, thereby enhancing the reliability and validity of our findings. The systematic literature review is willing to identify and synthetize existing evidence on lean implementation frameworks in the manufacturing context to have a broader vision of what are the different models for this implementation context. Thanks to that, according to the luxury production characteristics, a selection of the best framework that can fit the lean application in this domain will be done to answer the RQ.

3. Results and discussion

A comprehensive search strategy was developed to identify relevant literature across Scopus databases. The search query was generated based on the intersection of two main research areas: "lean manufacturing implementation" and "lean framework." To extend the pool of results, synonymous terms such as "lean transformation", "transition to lean", "lean implementation", "lean manufacturing", "implementation approach", "lean roadmap", "lean model", "lean structure", "lean scheme", "lean plan", "lean methodology" were included in the query. Boolean operators like AND and OR were used to combine search terms in different patterns, ensuring completeness and specificity in retrieving relevant literature. The query outlined is the following:

TITLE-ABS-KEY(("lean manufacturing implementation" OR "lean transformation" OR" transition to lean" OR ("lean implementation" AND "lean manufacturing") OR ("implementation approach" AND "lean manufacturing")) AND (("lean framework" OR "lean roadmap" OR "lean model" OR "lean structure" OR "lean scheme" OR "lean plan" OR "lean methodology") OR ("lean" AND ("model" OR "framework" OR "roadmap" OR "plan" OR "scheme" OR "structure" OR "methodology"))))

Upon completion of the initial search, a total of 523 articles were retrieved. These articles underwent a filtering process based on subject area and language specifications. Specifically, articles outside the domains of BUSINESS, MANAGEMENT & ACCOUNTING, and ENGINEERING and with a different language from English were eliminated leading to 84 articles excluded from the systematic review. Moreover, 5 articles were identified as duplicates and thus excluded as well to streamline the subsequent phases. In this way, the first step of the PRISMA diagram led to obtain 434 articles.

After that, the review process focused on identifying and selecting pertinent literary materials. Various types of literature, including literature reviews, conceptual, descriptive, and empirical papers (such as case studies and surveys), were considered for inclusion in this systematic literature review (Antony et al., 2021). Subsequent to the initial screening, a more detailed assessment was conducted to eliminate studies that fell outside the scope of the research, in the appraisal phase. This involved reviewing titles, keywords and abstract to exclude papers unrelated to the research topic. A total of 375 papers were excluded at this stage, leaving 59 papers for further consideration. It was considered out of scope all the articles not pertaining directly and indirectly the implementation phases of the framework and investigating it in different fields than manufacturing - some articles were dealing with critical success factors for lean implementation others implementing it in accounting, lean construction, logistics, maintenance, product development, service industry, supplier development, and warehouse management.

Then, with the synthesis step, for the remaining document, it has been performed a full-text reading which led to the removal of 39 articles, including for our systematic literature review 20 documents. This final step has seen the exclusion of these papers because they were not specifically focused on the steps of implementation for lean principles and were not contributing to our research. For instance, after full-text reading, the frameworks that were proposed in the abstract, resulted to be more focused in the assessment steps rather than the implementation ones, thus missing the scope of the research. The result of the PRISMA diagram can be seen in Figure 1.

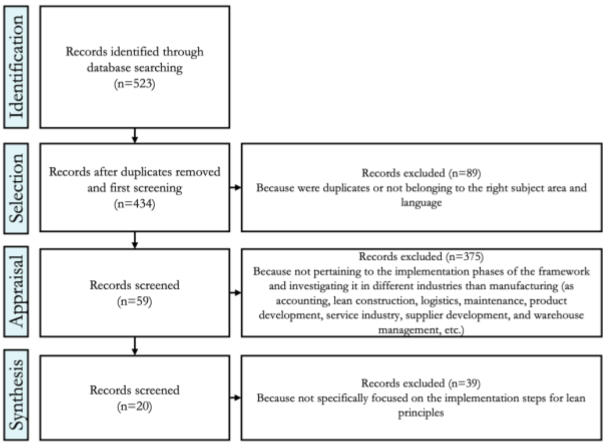

Figure 1: PRISMA diagram

As a results, the overall systematic literature review with the papers reviewed can be divided in three clusters: the first one dealing with papers focused on the implementation phase of lean implementation framework, the second one which was more focused on the selection of the right lean tool and prioritization of alternatives and the last one highlighting the overall implementation steps - or just the preparation and check phases - as for DMAIC methodology.

Starting from the first cluster, Value Stream Mapping (VSM) emerged as a prominent and widely utilized tool in lean implementation initiatives (Maqbool et al., 2019). VSM facilitates the visualization and optimization of material and information flow, aiding in waste reduction and lead time reduction. Notably, VSM is often integrated with other methodologies such as fuzzy Quality Function Deployment (QFD), fuzzy Failure Mode and Effect Analysis (FMEA), 6R, and 5S to enhance its effectiveness (Kumar et al., 2023; Mohanraj et al., 2015; Pandey et al., 2022; Bhuvanesh Kumar and Parameshwaran, 2018; Maqbool et al., 2019). Mohanraj et al. (2015) delineated the steps involved in Value Stream Mapping (VSM), which encompass identifying the product family, mapping the current state, and developing a future state map by incorporating improvements. In this case leanness performance measurement significantly improved despite fuzzy QFD time-consuming and complex activities and requested periodical evaluation of prioritization of improvements. Maqbool integrates VSM with 6R obtaining an outcome that can be described as simplistic and easy to adapt to different manufacturing sectors and results to improve all three sides of sustainability (economic, environmental, social). This process serves as a roadmap for streamlining operations, integrating suggested modifications to attain a leaner future state (Kumar et al., 2023). Pandey et al. (2022) propose the usage of VSM in accordance with 5S tool and the benefits grasped are the improvement of operational measures and the increment of overall profit in the supply chain of the carpet manufacturing industry. Although they face challenges as the resistance to change by employees not involved in the project, showing a lack of communication that could be an obstacles for the success of the improvement. In a similar vein, Scott (2007) propose a holistic roadmap for effective lean transformation, comprising five sequential steps. It begins with the specification of value within a process, followed by the identification of value addition and waste. Subsequently, the focus shifts to creating flow within the process and implementing customer pull for output. Finally, the pursuit of perfection in the value stream, aimed at serving the customer optimally, completes the transformation journey (Scott, 2007).

The second cluster identifies frameworks utilized to prioritize and assess lean tools employing Multi-Criteria Decision-Making (MCDM) approaches like Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and COmplex PRoportional ASsessment (COPRAS) (Kumar et al., 2023). Kumar et al. (2023) propose a framework that employs VSM with plant layout to identify and eliminate waste. Then, they prioritize and assess lean tools through two different MCDM approaches, namely TOPSIS and COPRAS. The COPRAS assesses and selects appropriate alternatives among the available possible choices (Kumar et al., 2023). This paper has proven the successful methodology having as a results improved operational and sustainable performances, as reduction of inventories and better customer service. They underlined also the importance of experience of experts using this framework, because according to that the model effectiveness can vary. While another paper from Kumar et al. (2023) integrates the VSM tool with Fuzzy Integrated Analytic Hierarchy Process (AHP) and COPRAS to prioritize wastes and lean tools. This methodology helps practitioners to select and implement the right lean tools and also in this case the people involved in the usage of the method should have a deeper understanding of the context, the lean principles and the optimization tool. This is applied in a large-scale production and it can be seen as a limitation for other types of manufacturing context. Most frameworks integrate fuzzy logic to mitigate the drawbacks of crisp number calculations, such as the incapacity to manage judgments that lack specificity and the inability to evaluate uncertainty. Based on this, Fuzzy COPRAS is introduced to handle inaccurate and imprecise judgments by experts, while Fuzzy AHP calculates the relative importance of identified wastes with respect to one another through pairwise comparison matrices (Kumar et al., 2023). Then, the systematic implementation of lean practices for successful implementation involves prioritization and strategizing. Chaple et al. (2018) developed a framework based on interpretive techniques such as Interpretive Structural Modeling (ISM) and Interpretive Ranking Process (IRP). The IRP approach allows the ranking of the lean practices according to key performance metrics to generate new knowledge for better decision-making, while the ISM methodology excels in building the hierarchy of relationships for key lean practices using expert judgments (Chaple et al., 2018). This framework requires prioritizazion of lean practices in accordance to measures to be improved and should be used by lean practitioners. If used effectively it can end to be a model leading to the development of strategies for lean implementation, resulting in a financial benefit.

Thirdly, authors like Chong and Perumal (2020) propose conceptual lean manufacturing frameworks divided into different steps. They outline four phases: Plan, Do, Check, and Act (PCDA). Each phase involves distinct activities, from project planning to continuous improvement reference. Zaky et al. (2023) introduce a holistic framework for evaluating lean implementation levels and related production wastes, combining qualitative and quantitative analysis. This methodology, applied in the iron and steel manufacturing factories, recognizes wastes in inventory, time, quality and workforce and is able to guarantee an improvement in all these areas. The authors suggest to identify interrelationship between lean initiatives after they have been identified. In this framework, lean implementation incorporates the lean six-sigma (LSS) philosophy through the use of the Define-Measure-Analyze-Improve-Control (DMAIC) approach (Zaky et al., 2023; Rifqi et al., 2021). DMAIC, highlighted by Rifqi et al. (2021) as the most recognized framework for lean implementation, emphasizes the value in each step. Bhuvaneshwari Alias Sunita Kulkarni, M., Anand H. Mishrikoti (2019), and Gupta et al. (2012) concur, utilizing this five-phased methodology to address specific challenges and achieve performance goals. Conversely, Cortes et al. (2016) propose a sixth step, emphasizing alignment between operational and strategic levels. Driouach et al. (2023) delineate two types of frameworks: one comprising pre-implementation, implementation, and generalization phases, while the other focuses on preparation, execution, and lock-in. Additionally, Djassemi (2014) offers a three-phase framework centered on training, kaizen events, and implementation, omitting the post-implementation phase. It is applied in small manufacturing shops with LVHV and requires formation of specific teams and training by external consultants. He has recognized in the VSM a powerful tool to put in parallel to his steps to guarantee a waste free future state. Karim and Arif-Uz-Zaman (2013) consolidate essential components of lean implementations into a framework integrated with Continuous Performance Measurement (CPM). Their model encompasses production and process details, lean team creation, performance definition and evaluation, current process mapping using VSM, performance measurement, appropriate lean tools and continuous performance improvement techniques selection, and long-term method establishment. It results to be a systematic lean implementation methodology successfully implemented notwithstanding the fact that this is the first known study doing it and requires more testing. In contrast, Matharu and Sinha (2019) advocate for the Situation-Actors-Process-Learning-Actions-Performance (SAP-LAP) framework, which combines hard and soft systems thinking, collaborative learning and action, and performance metrics, adaptable to various contexts. Initiating the lean implementation strategy, the stabilize phase, as outlined by Dopp and Moran (2010), creates an environment for improvement, followed by effective change implementation, lean system establishment, standardization, expansion, and continuous improvement. Conversely, Goshime et al. (2019) structure firm transformation into four phases: existing, lean, output, and impact (ELOI). Transitioning from a non-lean to a lean firm involves applying VSM and waste elimination, leading to reduced costs, cycle times, lead times, and WIP inventory, while increasing delivery, quality, capacity, and resource utilization, ultimately enhancing productivity and customer satisfaction.

4.Conclusions

The fashion industry faces pressing challenges, particularly in terms of sustainability, amidst concerns over environmental impact. Luxury fashion, with its distinctive characteristics such as high customization and craftsmanship, navigates a complex landscape of market demands and production intricacies. Lean manufacturing principles offer promising solutions to these challenges, aligning well with the industry's goals of reducing waste, enhancing efficiency, maintaining product quality and aligning with sustainability objectives.

This systematic literature review aimed to identify and analyze existing frameworks for implementing lean manufacturing principles in the luxury fashion industry. By synthesizing findings from diverse research articles, the study sought to provide insights into effective strategies tailored to the unique dynamics of luxury clothing manufacturing.

Based on the comprehensive review of existing literature and frameworks, determining the most appropriate framework for implementing lean principles in luxury fashion manufacturing requires careful consideration of the industry's unique characteristics and challenges. Luxury fashion production, characterized by high customization, craftsmanship, and premium pricing, presents distinct complexities that must be addressed in any lean implementation strategy. Considering these characteristics, the most suitable framework for implementing lean principles in luxury fashion manufacturing should exhibit the following key attributes: flexibility and adaptability, given LVHV and craftsmanship environments with high customisation and human taskforce; lean principles should complement rather than compromise the artisanal craftsmanship and the framework should integrate the value of craftsmanship while streamlining processes to minimize waste and enhance efficiency; prioritize quality ensuring sustainability initiatives throughout the production process; strategically align with company's objectives and promote collaboration across stakeholders; promote lean culture of continuous improvement for a long-term result and avoid any employees frictions to change.

Considering these factors, a holistic approach that combines elements from various frameworks may be the most effective strategy for implementing lean principles in luxury fashion manufacturing. Because of the high adaptability to this heterogeneous context, the VSM can be a suitable choice, given also the fact that it can be mixed with different techniques (as lean tools, sustainable practices) and it is easy to implement. While methodologies added to VSM, as MCDM approaches, would require an expert implementation to obtain fair results. Also, DMAIC and frameworks involving steps as preparation, implementation and check, are methodologies that can be suitable options for the luxury fashion context, given also the feasibility with the LVHV environments previously explored. In the last case, VSM has been also recognised a powerful tool to use in parallel to framework involving steps to guarantee a waste free future state. Integrating tools such as VSM, MCDM, and the DMAIC methodology, could provide a comprehensive framework that addresses the industry's specific needs. Nevertheless, the DMAIC framework, not only results to be the most complete in terms of steps to follow precisely, but it is also the most common tool used for lean implementation in the manufacturing domain. Thus, it could be chosen to be the most appropriate for this industry because it ensures also flexibility and adaptability both according to different context of implementation and for its feasibility of working with additional different tools, which can be used in parallel to enhance its effectiveness while driving operational excellence and sustainability.

Limitations of this paper include the absence of empirical validation for the suggested framework tailored to the characteristics of the luxury fashion industry. While the framework proposed in this study integrates insights from existing literature and aligns with the unique challenges of luxury fashion production, its real-world applicability remains untested. Therefore, future research endeavours could focus on conducting multiple case studies within the luxury clothing industry to explore how the proposed framework performs in practice. By examining its implementation in diverse luxury fashion companies, researchers can gain insights into its effectiveness, identify potential challenges, and refine its components to better suit industry-specific needs. Other case studies could be conducted in different industries with similar production characteristics to extend the validity of this work. Another area for future research is the exploration of drivers and barriers associated with the implementation of lean methodologies in the luxury fashion sector. While this study primarily focused on classifying implementation frameworks based on their suitability for luxury fashion manufacturing, further investigation into the factors influencing the adoption and success of these methodologies is warranted.

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