Life Cycle Assessment on fashion industry: four case studies

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Abstract As one of the most environmentally harmful industries worldwide, the fashion industry urgently requires sustainable practices to mitigate its impact. This paper analyses the literature to determine the importance of a monitoring tool such as Life Cycle Assessment (LCA), as an enabler for the transition towards sustainable business models within the fashion industry. The aim is to analyse the literature to highlight benefits, limitations, and case studies that can serve as a basis for the implementation of this tool in fashion companies to make them more sustainable. This work is also a preparatory aim, for the creation of case studies that will be carried out in companies in the context of the Marche Region, Italy, where this industry has an important strategic and economic relevance.

Keywords: Fashion industry, sustainable business model, Life Cycle Assessment, Circular Economy

1. Introduction

The fashion industry is one of the most polluting in the world. It is estimated that the sector is responsible for about 9% of global emissions and contributes 20% of water pollution, as well as producing about 92 thousand tonnes of textile waste (Niinimäki et al., 2020).

The production phase bears a dual responsibility for this pollution, direct and indirect. Direct, because the production processes themselves are responsible for pollution. Indirect, because of indirect pollution (e.g., Scope 3 emissions), but also because of a lack of Life Cycle Design, or Eco-design, as this influences the downstream phases of the product life cycle up to the post-consumer phase, where it is costly or impossible to apply standardized recycling strategies.

This leads to linear and unsustainable business models, contrary to what would be necessary for the abatement of the impact of this sector.

Evidence of such problems and consequent attempts to react can be found in the literature.

Many technologies, models, and processes have been developed to improve current business models by acting at different levels of production. The authors already focused on this area, conducting a Literature Review on possible best practices for the transition to Sustainable Business Models (SBM), focusing on three key segments of the fashion industry, namely textile, footwear, and leather (De Ponte C., Liscio M.C., Sospiro P., 2023).

From a materials perspective, many technologies have emerged to reduce the impact of polluting production steps such as dyeing in textiles, e.g., (Santal A.R., Rani R., et al., 2022), or chemical adhesives in footwear, e.g., (Ruzafa-Silvestre, C., Carbonell-Blasco, M.P., et al., 2021), or cut-waste recovery in the leather, e.g., (Cabrera-Codony A., Ruiz B., et al., 2021).

However, the role of digitalisation is indispensable, for the efficient and timely monitoring of production and supply chain processes, enabling targeted actions to improve sustainability performance in all its dimensions (environmental, social, and economic), such as Industry 4.0 tools (Fromhold-Eisebith M., Marschall P., et al., 2021).

It is especially monitoring that assumes fundamental importance in the strategic decisions of companies to direct actions aimed at improving sustainability performance. Particularly, a useful tool for this purpose is the Life Cycle Assessment (LCA), starting from product and process design (Vezzoli C., 2017).

LCA addresses the environmental aspects involved throughout the entire life cycle of a product, from raw materials through production and use to end-of-life treatment and disposal (International Organization for Standardization, 2006).

The method proves to be a tool with multiple benefits to the company, both in terms of production eco-efficiency and image, with information that can be used also in marketing campaigns, as in the case study conducted by (Bevilacqua M., Ciarapica F.E., et al., 2011).

This work is a follow-up of a literature review done in the previous preparatory work (De Ponte C., Liscio M.C., Sospiro P., 2023) and it aims to investigate the role of LCA in improving sustainability in companies, in general, and in the fashion industry, in particular.

2. Methodology

In order to achieve that, a Systematic Literature Review has been conducted in the research domain of "LCA in the fashion industry", and the approach used was based on the steps proposed by the Scientific Procedures and Rationales for Systematic Literature Reviews – SPAR-4-SLR- by (Paul J., 2021).

Assembling, Arranging, and Assessing are the three steps.

Assembling is divided into two sub-phases: Identification, in which the documents to be evaluated are identified, and Acquisition, in which the first search for these documents is conducted on the designated databases. Identification encompasses the Research Domain in the scope of LCA topics connected to the Fashion Industry that have been thoroughly researched in the scientific literature.

The Arranging phase next includes the Organizing and Purification subphases, where the outcomes are screened.

Finally, the Assessing phase, which includes the sub-phases Evaluation and Reporting, evaluates the sources and information received and reports the results.

The results obtained through this process allow us to search for the benefit and limitations of LCA, as well as case studies that can be used as a guideline for the further step that will be conducted, in which four Italian companies will be analysed and an LCA will be conducted on them.

Particularly, the Marche Region context is the one where the companies will be involved, as for the strong presence of fashion producers and firms related to important fashion brands, with almost 6.000 fashion-related firms, 37.000 employees, and more than 15% value of the entire regional manufacture, only from the footwear industry (Regione Marche, 2021). This makes fashion a driving sector for the region, like a few in Italy and Europe. Four companies were identified in this context, related to four areas of investigation in the fashion industry, i.e., textiles, footwear, leather, and fashion accessories, and will serve as the basis for four case studies aimed at obtaining an LCA for each of these companies.

3. Results

There are several publications in the literature that have considered LCA as a driver to address sustainability in the fashion industries, both at the production level, e.g., (Wiedemann S.G., Biggs L., et al., 2021), (Rossi M., Papetti A., et al., 2021), (Roos S., Zamani B., et al., 2016), and supply chain level, e.g., (Wren B., 2022), (Seuring S., Muller M., 2008), (Moretto A., Macchion L., et al., 2018).

The analysis revealed how manifold the search results were, which were filtered to obtain the results most relevant to the topic of the search domain.

It was possible to distinguish different categories of papers in this process. Some dealt with LCA in a general way, describing its use in the sector, while others focused on particular case studies.

In the latter case, it was possible to distinguish the contributions both in terms of the specific reference sector - textile, footwear, leather, accessories - and the type of LCA used - product or organisational LCA.

4. Conclusions

With this paper, the authors provide a useful literature review for policymakers and academics working on this topic, providing the results of what is available in the literature, and propose the LCA method as a tool for improving companies' current business models towards a transition to circular economy models.

Furthermore, the study lays the groundwork for subsequent steps concerning the study of the four companies that will be involved in an LCA study.

This process will include a questionnaire for the companies with a twofold purpose: the first is to understand the company's processes and thus identify areas of improvement on which to focus in order to make the business model more sustainable; the second is to acquire the primary data for the LCA, in order to make the analysis as accurate as possible in terms of estimates.

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