

Review

From a Systematic Literature Review to a Classification Framework: Sustainability Integration in Fashion Operations

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Abstract: Sustainability management in global fashion operations is an area of growing concern. This can be seen by the number of research articles and industrial reports published. To establish a further debate, this study pursues two objectives. Firstly, it provides a systematic literature review pertaining to environmental and social sustainability management in fashion operations by encompassing 38 research articles indexed in Scopus from 2006 to 2016. Secondly, it presents a classification framework in which sustainability practices are categorized according to a three-dimensional concurrent engineering framework by focusing on product, process and supply chain levels. Results address that the breakdown of environmental and social sustainability practices identified in earlier research is not homogenous. For instance, some critical social aspects such as human rights are not widely covered in production processes. Similarly, serious environmental aspects such as biodiversity are not entirely focused on at the chain level. Last, this study concludes with a framework illustrating strategic priorities to be taken to advance sustainability in fashion operations.

Keywords: supply chain management; fashion industry; three-dimensional engineering framework; fashion operations; environmental sustainability; social sustainability; classification framework; systematic literature review

1. Introduction

Once upon a time, the fashion industry was subjected to the use of quotas that aimed to limit exports from specific countries. In 2005, the quotas were cancelled as a part of the Agreement of Textile and Clothing [1], and subsequently exports from certain countries largely increased. For example, in 2012, 42% of the EU27's clothing imports were supplied from China, 13% from Bangladesh and 13% from Turkey [2]. That is to say, due to the labour intensive nature [3] and relatively smaller amounts of skill and capital investment required [4], the competitive advantage of the fashion industry has shifted to developing countries over the last decade. In this global and highly competitive setting, the fashion industry, the world's third biggest manufacturing industry after automotive and electronics manufacturing [5], is characterized by mature production technologies, a large number of consumers, and globally dispersed supply networks that exceed the boundaries of a single company [6], where multi-tier suppliers, buying firms and consumers are linked.

Consequently, a significant environmental and social footprint is generated at various stages of global fashion operations [7]. Approximately 8000 synthetic chemicals are used to turn raw materials into textiles [8]. On the one hand, textile manufacturing pollutes approximately 200 tons of water per

ton of fabric [9]; on the other hand, it creates a substantial amount of fabric waste [10]. There is also a conflict between corporate social responsibility (CSR) and overarching commercial pressures in the fashion and apparel industry [11]. The International Labour Office [12] shows that 168 million children are child labourers that are mainly employed by textile and garment factories [13]. The most critical issues occur at the upstream level [14] and buying firms, which govern the supply chain (SC), design the product to deliver it to the market and are held responsible for environmental and social outcomes of their SCs [15–18]. Therefore, an effective equilibrium among common goals must be reached to ensure sustainability [19], as demanded by a number of stakeholders. To sum up, not only do fashion companies need to form strong and responsive SCs to reach market leadership [20], but they also need to revisit critical success factors to incorporate ethical aspects and sustainability [21]. However, the industry is challenged by various factors, such as limited capabilities of small and medium sized suppliers [22], difficulties faced in transferring socially responsible behaviours to suppliers operating in developing countries [23], and variations pertaining to governmental regulations.

Aforementioned facts leave both practitioners and scholars showing a growing interest in sustainability in fashion operations. As a consequence, the existing literature delivers contributions, which appear to be limited. Among the publications acquired for this study, only seven papers attempt to provide a systematic review or a descriptive study based on content analyses. In the authors' opinion, there is a need for a comprehensive review of environmental and social sustainability integration at various levels of fashion operations. Based on a content analysis, Kozłowski et al. [18] identify indicators disclosed in sustainability reports, other documents and corporate websites of 14 fashion and apparel companies that belong to the Sustainable Apparel Coalition (SAC). Subsequently, 87 sustainability management indicators were identified, among which the majority of the indicators dealt with SC sustainability. While delivering significant results, the paper fails in providing a judgement pertaining to the level of performance. Further, there appears to be a need to standardize and group such indicators in order to assign them to the categories and aspects in the sustainable business model. Mukherjee [24], on the other hand, provides a descriptive study to make consumers aware of environmental and social outcomes delivered by fashion companies. Yet, the paper comes short in providing a rigorous review to put forward some distinctive production or SC strategies. Resta [25] conducts a comprehensive analysis of the practices employed to reduce environmental impact generated in fashion SCs (FSCs). Even though the framework mapping the practices is inclusive, solely environmental sustainability is covered. Therefore, an extension to social aspects is needed to embark on a more holistic approach. Turker and Altuntas [2] attempt to map the current situation of sustainable SC management (SSCM) in the fast fashion industry through a content analysis of nine companies using the same reporting principle. It is addressed that compliance, monitoring and auditing are the principal components of SSCM. Nevertheless, the study only relies on a limited number of documents, coming from the industry. A more comprehensive review would be more desirable to deliver a more complete discussion on how and to what extent actual performance could be advanced throughout the entire chain.

Considering that working processes of the fashion industry can easily cause worker injury, and even death [26], and the need for environmental protection, as well as the growing demand for natural resources [27], revisiting business models and restructuring SC operations, are needed. Even though sustainability and fashion have been considered an oxymoron [28], fashion operations and sustainability management should not be perceived exclusive. A fashion product can be called sustainable only if environmental and social performance of production processes and SC strategy is ensured. In a full alignment with the definition outlined by the United Nation's World Commission (for a full definition please refer to the World Commission on Environment and Development (WCED) [29]), fashion operations must balance various and competing needs without compromising environmental and social rights. Without a complete picture, the comprehension of the current situation regarding sustainability integration in global fashion operations cannot be obtained. Filling this gap, a systematic literature review has been conducted to collect and analyse all relevant studies in the field. Accordingly, the goal of this study is twofold: (i) to outline the results of a systematic literature review on fashion

operations and environmental as well as social sustainability; and (ii) to provide a classification framework capturing all elements of fashion operations and sustainability management. The remaining of this paper is organized as follows. Section 2 presents the methodology employed in this study. Section 3, subsequently, displays analysis and the findings. Discussion is elaborated in Section 4, and lastly, Section 5 delivers the conclusion of the study.

Fundamental Terminology

This section attempts to provide a basic terminology before going further in the analysis. The SC encompasses all activities associated with flows of materials, goods and information, at both upstream and downstream levels [15,30]. The FSC, correspondingly, contains a number of inbound and outbound management practices [31] to achieve a common goal of converting raw materials into finished products and then delivering these products to the final consumers. The FSC is characterized by high demand and low supply uncertainty [4]. Likewise, the industry is differentiated by shorter product life cycles and highly volatile market demand [32] alongside downward price pressure, international sourcing, high product variety and low predictability [4]. The SC management (SCM) is defined as the integration of many critical activities to remain competitive in a context in which most activities are outsourced and the interaction of multiple actors is critical [33]. In this setting, SCM is regarded as causally ambiguous as well as socially complex and, therefore, not easily imitable by competitors [34].

As formulated by prior research, the right SC strategy contains SC configurations, which are related to the number of tiers in the SC, number of players in each tier, etc., and SCM practices, which are related to the use of information sharing tools, management practices, etc. [35]. Thus, the SC strategy must be aligned toward the critical success factors of the considered product and/or market [36]. Pal and Torstensson [37] show that most of the critical success factors can be synthesized and sustained through a three-dimensional concurrent engineering framework; that is, a simultaneous design of product, process and SC levels. Focusing on product, process and SC levels is considered beneficial in interpreting holistic and market-responsive design through linkages generated by dynamic capability development and innovation [37]. This review aims to address not only intra-, but also inter-organisational, issues. Hence, in line with these definitions, yet extending to the relevant terms, process, product, supply chain and fashion industry are all encompassed in this study.

2. Research Methodology

The data collected for this study contains a systematic approach to the literature analysis. A systematic literature review is convenient to minimize researcher bias regarding the inclusion or exclusion of studies and to clearly channel how and to what extent the review was performed through transparency. The key steps for a systematic review, as described in detail by Johnsen et al. [38], consists of planning the review, conducting the review, and reporting the findings. This section addresses the planning and the conducting of the review. This study employs a transparent four-step process, which is shown in Figure 1.

Firstly, it is vital to clearly explain how the filtering approach was deployed. In this vein, inclusion and exclusion criteria were evidently set. We included only peer-reviewed journal articles in the search. This decision was made due to the fact that peer-reviewed journals are considered the most common forum where researchers publish their findings. Further, since sustainability in fashion operations is a relatively new but rapidly growing area, this review was not limited to empirical studies but also included conceptual and review papers. This ensured that research articles were not discounted based on a particular methodology as long as they were relevant from a management perspective. This study excluded newspapers, conference papers, textbooks and unpublished papers, since it was contemplated that relevant content that could have come from such excluded resources have likely been seen as a pre-cursor in the academic papers. All in all, the review focused on the core of academic research and it could emerge as a relevant state-of-the-art research, which is applicable to strategic industry features. In order to perform the initial search of relevant articles, the Scopus database

(Elsevier, Amsterdam, The Netherlands) of peer-reviewed literature was selected. Scopus, which possesses an extensive global coverage of research articles, enabling researchers to capture a wide range of relevant publications, has been widely used for systematic review studies [39–41]. Thus, we confined the review to the extant literature found in journal articles referenced by this database.

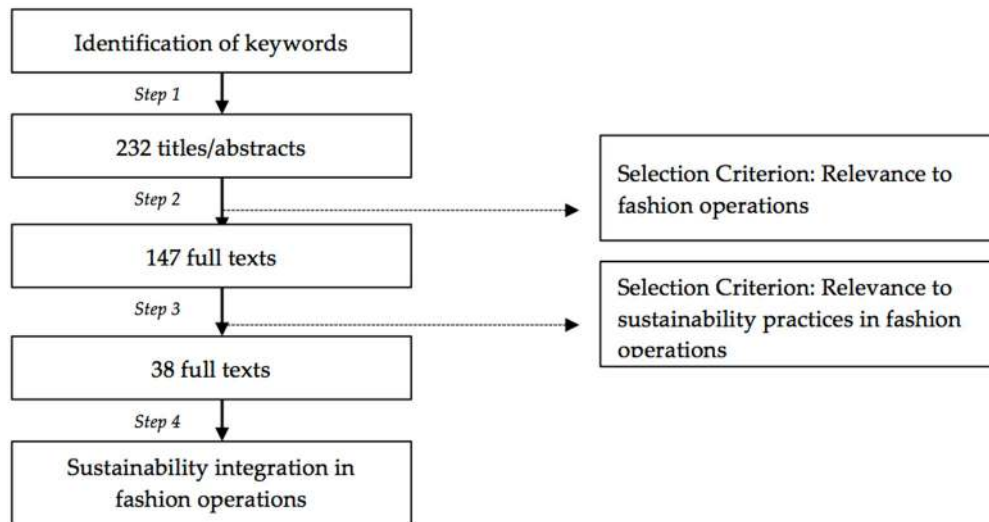


Figure 1. Flow chart of the research process.

Successively, a combination of keywords was identified. As previously outlined, the attempt was to identify the underlying theoretical and managerial perspectives to better understand sustainability integration in fashion operations. To this end, there are a number of conceptual benefits of integrating the three-dimensional concurrent engineering framework (3DCE) (product, process and SC) with sustainability. Such benefits include competitive advantage, reduced operating costs, improved image, differentiation, reduced risks and reduced regulatory compliance costs [42], and further, the framework was appropriately used to study sustainability issues in the fashion industry [43].

Keyword identification was a challenging process, as the research team aimed to detect and capture all articles written for the fashion industry in the domain of operations management and sustainability. The analysis focuses on the most recent studies, since this study attempts to provide state-of-the-art results. To this end, a start date was identified as 2006 and papers were tracked until 2016. When a time span expanded, the total amounts of research articles from the second and especially third steps were found to be drastically dropping. This articulates that operations management in the fashion industry and sustainability received more attention, especially after 2010.

Accordingly, the following search items were utilized: (fashion industry) AND (product OR process OR supply chain), and the search terms were carefully examined in titles, abstracts and keywords. These carefully chosen keywords and the method of focusing on titles, abstracts and keywords assured that all relevant articles were duly included. Following the keyword identification, Step 1 resulted in 232 research articles. The authors did not include sustainability among the keywords, because sustainability is a multifaceted topic in which there are many synonyms referring to the notion “being sustainable”. It was observed that some contributions focus on ethical aspects, which must be included in the review, while some other studies solely focus on the environmental axe of sustainability. For example, an alternative search attempt was made and sustainability was inserted along with other search items. Nevertheless, (fashion industry) AND (process OR product OR supply chain) AND (sustainability) brought only less than 30 journal articles. The authors perceived this number rather skeptically, and to counter this, this study opted to search for the synonyms of sustainability—encompassing a wide range of possible combinations amongst eco, ethical, environmental, CSR, social, socio—through a comprehensive reading process. This approach

enabled us to cover all type of studies, including the ones focusing on only one facet of sustainability (e.g., CSR or eco-innovation would not have appeared in the database unless they had been specifically accessed in the main text). (Please refer to Appendix A for further details).

Following Step 1, which resulted in 232 research articles, the filtering process continued with Step 2. The initial list of 232 was reduced by checking the abstract and full text for relevance to fashion operations, deselecting those focusing on, for example, marketing, branding and consumers rather than organizational facets. This step resulted in 147 full texts with a relevance to fashion operations. Subsequently, in Step 3, all of the remaining papers were then filtered according to their relevance to sustainability. So as to create a clearer picture of how the field is structured in terms of sustainability standpoints, the analysis was done by searching through each paper to decide if there were any considerate declarations about any sort of environmental or social sustainability practices/programs/tools integrated in fashion operations within any of the 3DCE stages. This ensured that any relevant information pertaining to social and/or environmental sustainability was not missed from the publications. Accordingly, the review process enabled the construction of a database consisting of 38 research articles truly focusing on sustainability integration in fashion operations. Accordingly, all types of social and environmental sustainability practices implemented in fashion operations were identified and categorized in Step 4, which led to the creation of the taxonomic scheme of this study. Figure 1 displays the flow chart of the research process. The next section elaborates research analysis and the main findings.

3. Towards a Classification Framework: Results

3.1. General Overview of Publications by Country, Year and Journal

The review shows that the identified 38 research articles came from 18 countries, which are summarized by Figure 2. It becomes visible that China, Italy and the UK take the lead, with the highest number of research articles focusing on sustainability in fashion operations.

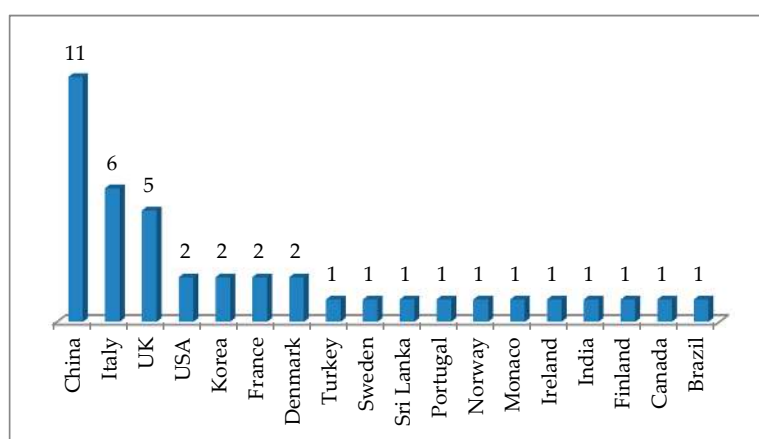


Figure 2. Overview of the research articles by country.

Additionally, Figure 3 displays the distribution of the research articles with a relevance to fashion operations across the study period between 2006 and 2016. The average number of articles published each year accounts for around 14. It is acknowledged that research focusing on the fashion industry with a specific drive toward operations management accelerated after 2011, though, with an unbalanced trend. This finding is aligned with that found for sustainability, and it suggests that sustainability in operational fashion management is a relatively new but certainly a growing research area. Figure 4, similarly, displays the distribution of the articles focusing on at least one facet of sustainability. The average number of sustainability-associated research articles published each year is approximately three point eight.

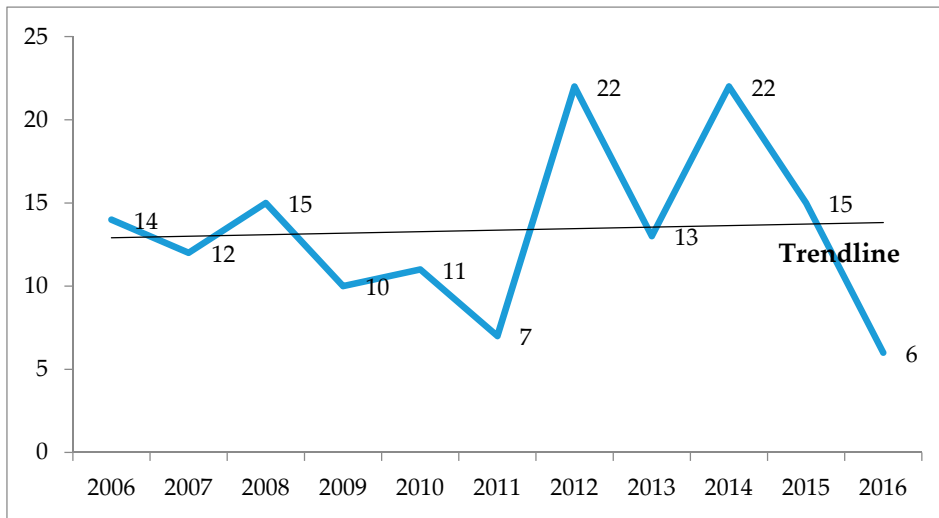


Figure 3. Distribution of the research articles focusing on fashion operations.

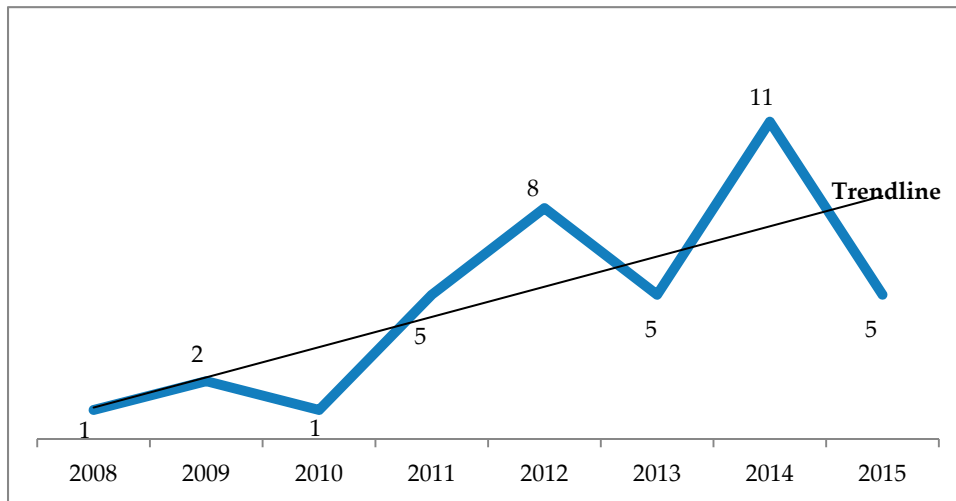


Figure 4. Distribution of the research articles focusing on sustainability in fashion operations.

At large, in the years 2006 and 2007, we could not find a research article focusing on fashion operations with relevance to sustainability. In 2008 and 2010, only one paper per each year was published in this domain. The highest rate of publications belongs to the years 2014 and 2012, in which 11 and eight research articles were published, respectively. Overall, the number of publications addressing any kind of environmental and/or social sustainability practices in fashion operations, in the form of product, process and/or SC levels, illustrates an unbalanced trend over time. This indicates that there is an awareness attracting both practitioners and academics; however, investigating sustainability in complex systems, such as the labour-intensive and globally dispersed fashion industry, is challenging. Nevertheless, external drivers, such as market forces and legislative frameworks, constantly challenge companies to disclose their performance results and to advance their sustainability strategies. Therefore, we anticipate an upward trend in the near future, since many questions, particularly in terms of social issues, remain unanswered.

Regarding the distribution by journal, *Sustainability* and *International Journal of Production Economics* emerge as the greatest sources. The following largest source is *Journal of Fashion Marketing and Management*, while the next largest source ties three different sources, namely, *Business Strategy*

and the Environment, European Management Journal, and Resources, Conversation and Recycling, Figure 5 displays the distribution of 38 research articles per journal.

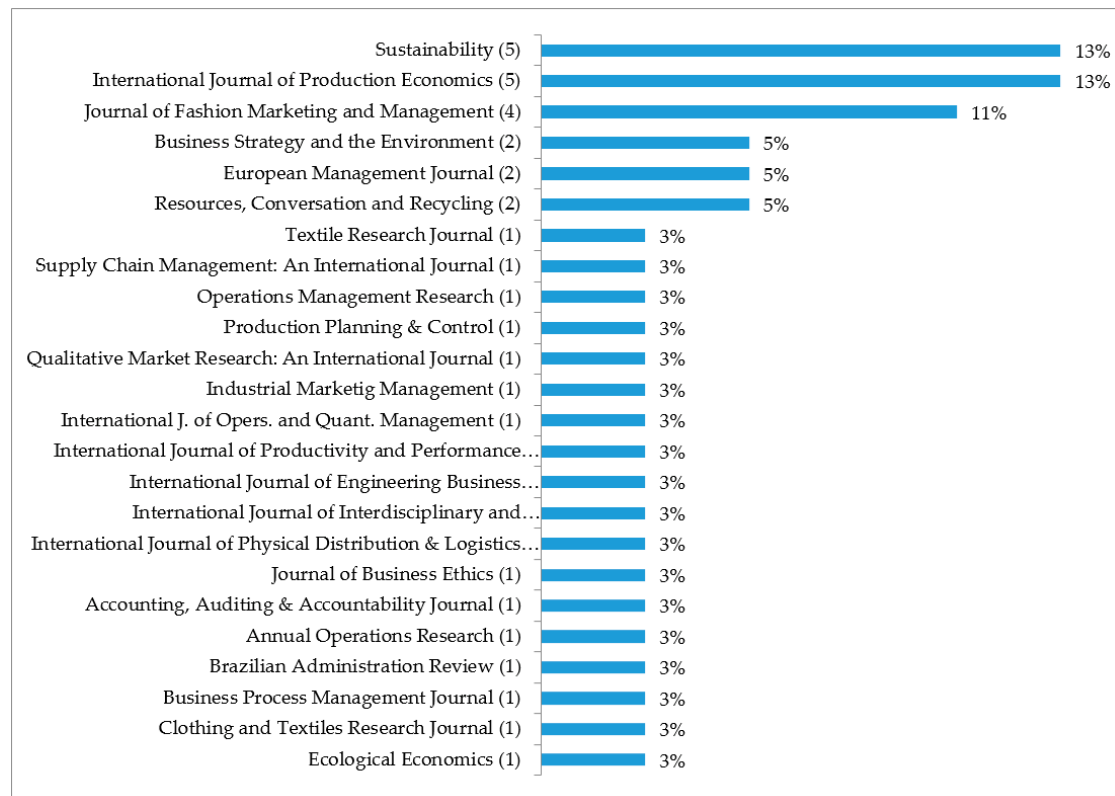


Figure 5. Distribution of the research articles by journal.

3.2. Environmental and Social Sustainability Integration in Fashion Operations

In order to develop the classification framework, each journal article was carefully reviewed and analysed. Precisely, the research team identified (i) the sustainability practices implemented; (ii) the specific 3DCE stage where the practices were employed and (iii) the specific category and aspect to which the certain practice pertained. On the whole, sustainability practices implemented in fashion operations were categorized based on their applicability into the 3DCE stages. In the classification framework—displayed in Appendixes B–D—individual practices have been assigned to categories and aspects, which were generated in pursuant of Global Reporting Initiative (GRI) G4 Sustainability Reporting Guidelines and the UN Global Compact’s Ten Principles. In order to reduce the bias, three independent researchers subsequently reviewed the framework and necessary adjustments were accordingly made. It could be stressed that the distribution of sustainability practices in specific aspects to be applied to a number of operational stages identified various prerequisites that could help embark sustainability holistically.

A total number of 101 sustainability practices were obtained from the existing literature. On the whole, 62 environmental sustainability practices, accounting for 61% of all sustainability practices, were implemented in fashion operations. Social sustainability, on the other hand, was implemented through 39 practices, holding 39% of all practices. As depicted by Figure 6, 23% of all sustainability practices (23 practices out of 101) was embodied in product design, while 35% of all sustainability practices (35 practices out of 101) was implemented in production processes and 42% of all sustainability practices (43 practices out of 101) was deployed at SC level.

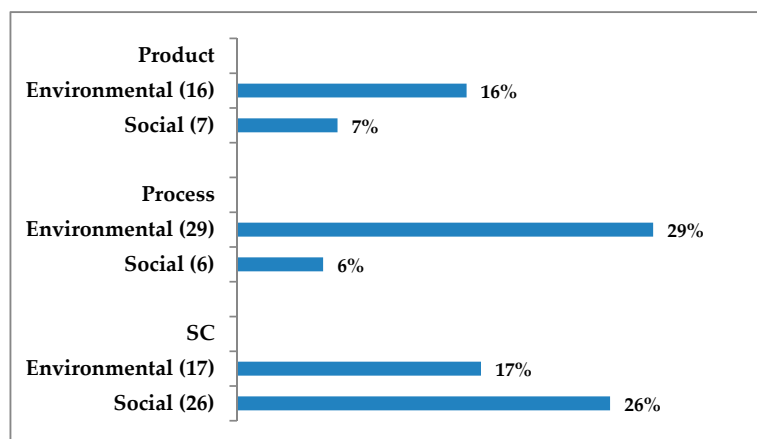


Figure 6. A breakdown of the percentage and the number of all sustainability practices for each stage of the three-dimensional concurrent engineering framework (3DCE).

The following section elaborates a breakdown in terms of environmental and social aspects.

3.2.1. Sustainability Integration in Product Design

As displayed in Appendix B, in total, 23 practices (accounting for 23% of all sustainability practices) pertain to product design. It was observed that 26% of all environmental sustainability practices, referring to 16 environmental practices out of a total number of 62, was scored in product design. More specifically, “materials” emerge as an up-to-date aspect in which fashion companies frequently implement a wide range of practices. Use of organic cotton as well as eco-friendly materials holds a pivotal role in eco-design. Patagonia, one of the pioneer companies in the subject, has 100% certified organic cotton products since the beginning of the 1990s [43,44]. The fashion company, Eileen Fisher, on the other hand, has a project featuring fully fashioned knit sweaters made of 100% long staple organic cotton, grown, spun and knitted in Peru [7]. Likewise, 11.4% of the cotton used by H&M comes from more sustainable sources. Macchion et al. [45] also exemplify fashion companies developing an organic cotton product line and an organic stocking collection made out of bamboo. Furthermore, Oskar Metsavahat from Osken involves the idea of simplicity, design and materials from sustainable sources [46].

It is worth stressing that reduction of chemical components alongside colorants is increasingly embedded in product design strategies. Predominantly, companies design their products by considering green values, by using recycled and certified raw materials, by conducting life cycle assessment (LCA) studies and by pursuing cradle-to-cradle design principles to minimise their footprints. In 2002, Puma launched “the Top Winner Thrift” of 500 unique pairs of trainers made out of recycled materials [44]. On the one hand, recycled polyester, equivalent to 7.9 million plastic bottles, is used in H&M products; on the other hand, 7.4 million pairs of shoes are manufactured by using water-based adhesives [19]. Similarly, Marks & Spencer launches a special suit line made of recycled materials while Timberland engages in developing biological textile production. Yet, despite such industrial efforts, there appears to be a lack of common understanding about the role of design in sustainability. Data obtained from publicly available information of 14 fashion companies address 87 sustainability indicators [18]; nevertheless, the indicators specified for product design show a great deal of variability (as a consequence of the creative nature of fashion). Undeniably, problems caused by the unsustainable landscape of the fashion industry need unconventional solutions for eco-design. To this end, Dissanayake and Sinha [47] examines the concept of fashion re-manufacturing to support material recirculation. Fashion companies must indeed develop and deploy capabilities to generate alternative business models to reduce the environmental footprint in such areas as biodiversity, water scarcity and waste, all of which seem to receive less attention from fashion companies.

As for the social axe of sustainability, 18% of all social sustainability practices, equivalent to seven practices out of 39 social practices in total, were implemented during the design phase. Even though the proportion seems low and more practices are still needed to advance social aspects, some substantial exemplars were observed. Labour practices and decent work appears to be the most pervasive aspect, amongst others. Earlier research highlights some companies pursuing fair trade principles in their manufacturing plants, while some others identify educational activities through which designers and farmers are given further knowledge on better design as well farming techniques. Product responsibility is another decisive pillar for social sustainability. In this sense, eco-labelling was attributed to highlight products' environmental as well as social information. Some other examples additionally address the growing moral values toward child labour and decent working conditions, e.g., no use of cotton sourced from Uzbekistan could be depicted as one of the most exceptional instances in this regard. Nonetheless, Jørgensen and Jensen [1] proclaim that product-oriented environmental policy attracted more reactive companies. For example, it was addressed that two of their sample companies skip eco-labelling strategy because the development of a more cooperative relationship with suppliers appears to be further complicated. It thus becomes obvious that the realization of more sustainable product design could only be achieved through a greater collaboration among all SC actors.

3.2.2. Sustainability Integration in Production Processes

Production processes are critical to encapsulate environmental and social sustainability practices. Nonetheless, direct control of sustainability becomes challenging in the case of a buying firm acting as a coordinator when its business functions are fully outsourced to third party suppliers, and this designates a noteworthy difference amongst fashion companies. Fashion companies belonging to haute couture and/or luxury segments often use a strictly controlled SC strategy to preserve knowledge and to concentrate on superior quality; whereas fashion companies operating in the mass market outsource their production processes to improve their responsiveness and on-time delivery performance. In agreement with what was previously addressed [43], we could stress that some companies appear not to have any internal production processes, and they therefore deploy sustainability actions in their warehouses, retail stores and/or headquarters. Companies having internal manufacturing processes, on the other hand, implement sustainability within their production processes.

As displayed in Appendix C, a total number of 29 environmental sustainability practices, accounting for 29% of all practices and 47% of all environmental sustainability practices, are executed in production processes. Hence, process design appears to be the core element of a sustainable strategy. Product certification and process certification account for a significant share in environmental practices. Resta et al. [25] address that a particular reference is paid to Oeko-Tex standard 100, Seri.co and Ecolabel. The Safilo group, the world leader in high-end market managing a brand portfolio of its own and licensed brands, directly controls research and product design, production phases, quality control of internal production, components bought from third parties and logistics [48]. Moreover, new technological advancements for more vegetable tanning processes are observed in an Italian company focusing on bags [45]. Waterless dyeing, on the other hand, is gaining importance to reduce the water footprint. Further, chemicals used in production processes are increasingly restricted, whilst harvesting rainwater and reusing treated wastewater emerge as some upcoming trends. Given the dramatic consequences of climate change, companies are aware of what their actions constitute in terms of carbon footprint. Therefore, emission reduction and carbon capture and storage are increasingly spotted in production processes.

It was observed that there is a limited commitment coming from the leather companies toward environmental sustainability. Companies from tanning processing are mostly interested in production process and water management, while footwear companies mostly embody practices concerning energy management [25]. Packaging, on the other hand, affects sustainability during various life cycle stages, e.g., when it is produced and then when it is disposed of. An improvement is thus needed to advance this aspect. Despite the efforts, it must be stressed that the carbon intensity of the industry is

somewhat instable, and emissions, effluents and waste represent substantial aspects requiring further attention. Additionally, the integration of social sustainability is not very comprehensive, as solely 6% of all sustainability practices (six social practices out of 101 in sum) are employed in production processes. Nonetheless, there are some interesting examples worth being highlighted. For example, manufacturers located in Sri Lanka were observed developing programs to address working age, and organizing programs to protect the female workforce. Yet, social sustainability still needs a bigger involvement to channel a persistent type of organizational thinking to better satisfy social needs of all members associated within FSCs.

3.2.3. Sustainability Integration in the Supply Chain

Design of the inbound SC is very decisive for those who outsource their production processes. Various intermediaries are also involved in fashion commercialism, and thus SC design from both inbound and outbound perspectives is very critical in terms of social and environmental impact. As detailed in Appendix D, the most frequently implemented environmental sustainability practices are listed as logistic optimization, environmental management systems, traceability, energy efficiency and hazardous chemical elimination. In 2011, Greenpeace issued a press release addressing the findings of its “Dirty Laundry” report on water pollution in Southeast Asia and China. This movement led to the “Detox” campaign, focusing on the elimination of hazardous chemicals in FSCs. In July and August 2011, respectively, PUMA and NIKE committed to eliminate hazardous chemicals from their SCs by 2020. Later on, G-Star RAW, LACOSTE and H&M committed to eliminate hazardous chemicals as well [49]. A major progress was observed in closed-loop SCs (CLSC). It was revealed that an efficient design of CLSC could not only mitigate environmental pollutions generated throughout the SC, but also increase economic benefits [50].

As previously asserted, more than half of the carbon emissions are generated by transportation activities between factories and stores. Accordingly, in 2009, H&M confirmed that 51% of its carbon footprint was created by its transportation activities. Thus, H&M arranged more direct shipments to avoid intermediate warehouses, and the volumes shipped by ocean and air have been reduced by 40% [9,51]. Benetton, on the other hand, maintains direct control over the logistics activities. A total integration within the production cycle is ensured through automation technology in real time [6]. Automated logistics processes and use of full-load capacity are some of the practical implications to optimize greener transport. As widely known, water scarcity and exploitation of natural resources are life-threatening topics. To this end, H&M promotes water savings in garment production with a water stewardship partnership with the WWF. Solvent-based polyurethane (PU) is also replaced with water-based alternatives. Furthermore, through a number of installations, more than three million litres of rainwater have been harvested [19]. Correspondingly, NIKE facilitates a strategic partnership with DyeCoo to introduce a facility in order to eliminate water use and chemicals during dyeing processes. End-of-life product management is also a pivotal zone for a further mitigation. GAP partners with Habitat for Humanity to collect jeans to create insulation materials out of post recycling [18]. Similarly, KINDY, a French group positioned in the underwear and sock segment, has improved information and communication technology (ICT) connections with its suppliers, has optimized the fill rate of the vehicles, and has actively implemented carton package recycling [44]. What was observed, interestingly, is that the return policy has been widely adopted in reverse FSCs, in which the retailer could return the unsold products and the supplier could re-sell or recycle them in a sustainable manner. However, it was found that, when there are more product returns, the degree of sustainability would be instinctively lower [52]. It was further explained that, if the cost of physical return is lower, the anticipated quantity of goods leftover is higher; so is the expected rate of return on investment. This could infer that a low logistic cost to return unsold products might not be beneficial to SC sustainability [52].

Further, social sustainability is largely taken on board in SC design. As depicted in Appendix D, 26% of all sustainability practices were implemented in the category of social sustainability at SC level, and therefore it could be commented that the proliferation of voluntary based sustainability initiatives,

including UN Global Compact, Universal Declaration of Human Rights, UN Rights of the Child, and ILO conventions, positively stimulates companies for a voluntary compliance. Compliance is becoming more and more relevant and is perceived as one of the prerequisites to improve SC performance, to avoid risks and to set clear supplier selection criteria [2]. As further evidenced by Fan and Lo [26], fashion retailers compulsorily use third-party certified occupational health and safety management systems and codes of conduct to monitor their suppliers' safety performance. A company could improve its safety climate through a number of health and safety initiatives, which would ultimately lead to better financial performance. Our analyses also demonstrate that the aspect of labour practices and decent work reflects an area of growing concern, as 11% of all sustainability practices dominate this aspect. Training programs provided on fire and safety, fair collective bargaining process between employees and employers and ethical purchase trainings became significant patterns.

Following the sweatshop scandals leaked in the 1990s, Eileen Fisher made a commitment to advance human rights conditions of upstream SC members. Supplier factories were then asked to apply international workplace standards and to protect basic worker rights [7]. A Swiss-based fashion company, Calida, and Spanish retailer, Mango, work to ensure the same working conditions, the know-how and the quality through compliance and certification [2]. H&M, correspondingly, is committed to help trade unions and employers in finding sustainable solutions in collective bargaining. For example, H&M met the Prime Minister of Bangladesh to express its support to raise the minimum wage for fashion workers [19]. Subsequently, 60% of H&M's colleagues have been covered by collective bargaining agreements. Further, both H&M and C&A address that they have joined a project of the Ethical Trading Initiative against a sumangali system in India. C&A additionally refuses to accept cotton from Uzbekistan until such serious problems (e.g., child labour) are solved [2]. However, firm size must be addressed as a prominent contingent variable in sustainability integration.

In 2006, the Sri Lankan national garment and textile industry body launched the "Garments Without Guilt" campaign in order to promote the country's ethical credentials to ensure that garments produced in Sri Lanka are made under ethical conditions. Nonetheless, in spite of increasing calls coming from retailers, price deflation leaves suppliers finding the capture of value-added opportunities challenging. Results of Perry et al. [11] also show that manufacturers offered narratives of engagement with CSR, yet this could not be always formalised in small businesses. Needless to say, a multilateral dialogue must be established among institutions, regulatory bodies and communities to increase awareness on social sustainability. It was additionally recorded that material producers were often not covered in monitoring programmes. However, cotton, for example, is an essential material for fashion products and the exclusion of raw material producers from monitoring activities is unreasonable [53]. Even though traceability and procurement certification create a momentum within the industry, moving further in FSCs toward raw material producers is urgently required to transparently confirm compliance. Regardless of a buying firm's serious commitments, if raw material producers are not transparently monitored, a consensus can never be reached on that product's real footprint. Global companies should not restrict sustainability to only a few tiers of their SCs; rather all significant actors contributing to their business practices must be included. Moreover, the results of Lueg et al. [6] unveil that a number of fashion store managers were uninformed about particularities of corporate sustainability. Information transparency must be obtained through knowledge dissemination throughout the entire chain. Therefore, all components of FSCs, both inbound and outbound, must be involved to keep corporate behaviour ethical.

It is also important to further emphasize that moving to a truly sustainable SC can only be ensured when all the stakeholders are considered. The downstream SC, where consumers are positioned, is also pivotal to holistically integrate sustainability. To this end, product responsibility emerges as a fundamental aspect, where consumer health and safety as well as privacy are secured. Consumers are expecting products to be functioning satisfactorily but they are also concerned for the health and safety risks. Thus, laboratory tests and disclosing information through a properly defined labelling strategy can be considered preconditions for the fashion companies.

4. Discussion

This study provides a comprehensive review of research articles to obtain further insights on how to integrate sustainability into fashion operations through the main operational stages of product design, production processes and SC execution. It then develops a classification framework to stipulate a well-established, as well as an applicable, taxonomy as a reference point. In light of the categorized practices, relevant information and insights are specified for both academicians and practitioners on the integration of environmental and social sustainability into various stages of FSCs. To this end, the peculiarities of such practices and the prerequisites of sustainability implementation are presented to help company managers prioritize their strategic decisions.

As outlined in the previous section, the breakdown of environmental and social sustainability practices into product, process and SC levels is not homogenous, and most of the sustainability practices are limited to certain individual functions. However, a more uniform integration must be put forward. For example, the development of technical and relational capabilities to be deployed at the SC level is more time and resource-intensive than the implementation of environmentally friendly practices at product design and production processes. Though, stakeholder engagement and SC partnerships are attributed as prerequisites to ensure product quality and better process performance results.

Sustainability at the product design level must aim at impact reduction that would be generated through the entire life cycle. Sustainable product, in this regard, could be linked with the implementation of environmental and social standards. For example, considering that 20,000 L of water is required to produce one kg of cotton [54], use of more sustainable materials could mitigate the impact. Sustainable sourcing, which could improve business measures [55], and the demand to procure lower carbon cotton could be further incentivized. Production processes, on the other hand, are important areas to take on board sustainability because sustainability advancement cannot only be related to the final products. Environmental and social criteria for production processes must be set as basic requirements. As defined by Seuring [56], environmental and social criteria, both for the products and the production processes, are often set and implemented by the focal company by which win-win situations could be obtained. However, to this end, comprehensive supplier audits are largely required.

It was found that a number of companies have launched supplier evaluation schemes, integrating environmental and social criteria, where suppliers are asked to declare how they address environmental and social issues. Conversely, it was also noticed that a more advanced communication, resource as well as know-how sharing and supplier development must be advanced in fashion operations. Therefore, the cooperation with suppliers gradually becomes essential, and this should certainly extend to first-tier suppliers, a situation which is often confronted in conventional FSCs. Hence, supplier development must be formed even before the design phase takes place. This, nevertheless, demands much more comprehensive information flows along the SC. Hence, we follow the footsteps of Beske and Seuring [57] and suggest that collaboration, including technologic integration, enhanced communication, pro-activity, including learning, stakeholder management, and innovation are strategic priorities for SSCM. Technology, which helps in increasing system efficiencies to decrease unwanted products [58], must be advanced into fashion operations. For example, substituting 10% of cotton fabric with a 50:50 polycotton-blended fabric might reduce the waste footprint by 1.7%, water footprint about 3% and carbon emissions around 0.4% [59].

On the whole, sustainability must consist of measurable standards and this could only be accomplished when it becomes a part of the day-to-day conversation, starting within buying fashion firms and continuing beyond company walls across the entire chain. Buying firms and manufacturers must agree on more equal and more realistic contractual agreements that would not unequally penalize any party [60]. Transactions should not be taken as a unit of analysis; rather a broader set of precautions, which would protect buying firms and suppliers, must be simultaneously considered. Still, this expanded foundation requires a closer communication and effective coordination so as to have a longitudinal picture. Consequently, this study concludes with a framework, which is shown in

Figure 7, consisting of actions in order to integrate environmental and social sustainability into product design, production processes and SCM in the fashion industry.

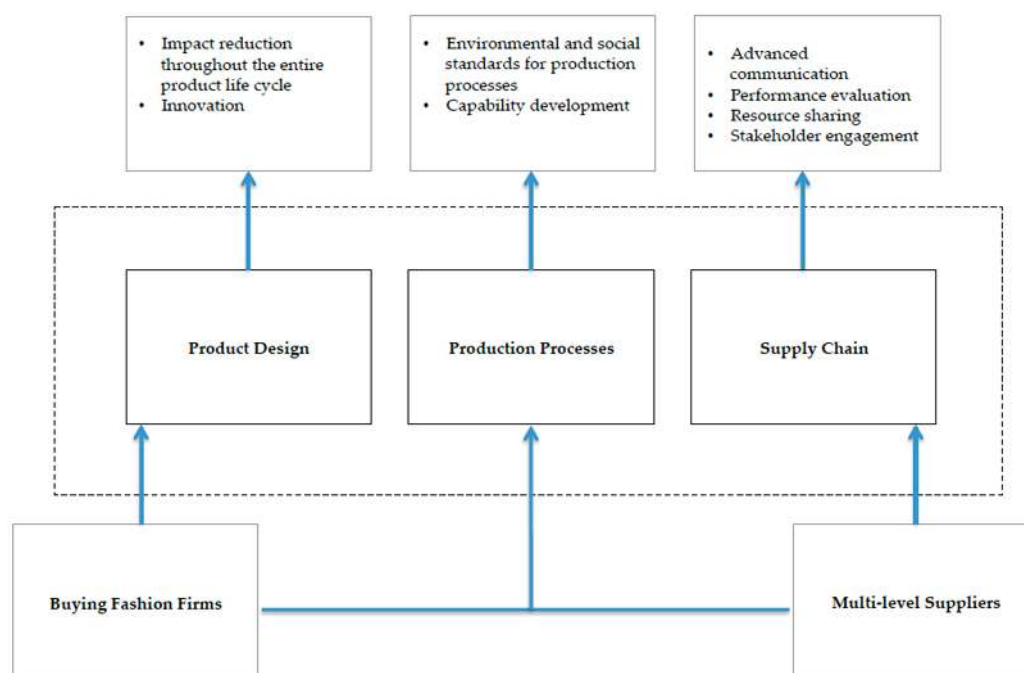


Figure 7. The Strategic Priorities for Sustainability Integration into Fashion Operations.

5. Conclusions

This study has taken a closer look at environmental and social sustainability at product, process and SC levels in the fashion industry. It provides a classification framework, embedded in Appendixs B–D and Figure 7, divided into sustainability aspects and categories at operation levels. The framework was derived based on a systematic literature review consisting of 38 research articles published from 2006 to 2016.

As displayed in Figure 7, proactive interaction between buying fashion firms and multi-level suppliers is needed to advance environmental and social stewardship across fashion operations. Sustainability must be introduced from the early stages of product design, by which impact reduction throughout the entire product life cycle could be assured. In this vein, many innovative solutions could reduce the footprint upon fashion delivery, for example, animal skin and feathers could be sourced from the meat industry; similarly fish skin could substitute for exotic leather. Nevertheless, a product could be called sustainable only when the production processes implemented at the chain level meet sustainability requirements. This study thus invites fashion companies to set environmental and social standards for production processes; yet, this should extend the boundary of conventional fashion SCM; that is, first-level suppliers, toward further upstream, e.g., raw material suppliers must also be included. To this end, supplier evaluation schemes integrating environmental and social criteria could be set as basic requirements. Production processes could go green through comprehensive supplier audits. To this end, training, resource sharing, performance evaluation and advanced communication must be stipulated throughout the entire chain to transmit sustainability at the upstream level.

In spite of this study's contributions, there are some limitations. Firstly, the findings are only coming from academic journals. Nevertheless, books, commercial journals and magazines might have interesting insights, too. Secondly, the article search was limited to one database, that is, Scopus (Elsevier, Amsterdam, The Netherlands). Even though Scopus is one of the most comprehensive academic sources, others may have covered the subject area. Thirdly, we only covered research articles published in a 10-year period, since we thought recent coverage would be more appropriate for

our investigation. Nevertheless, we hope that our suggestions and considerations could designate opportunities for researchers aiming to make contributions to the area. Lastly, future research could take a closer look at the relationship between sustainability and performance outcomes. It has already been addressed that the implementation of environmental sustainability could positively influence SC and firm performance [61,62]. However, we suggest that a rigorous correlation between performance outcomes and sustainability cannot be formed yet due to a lack in terms of long-term studies with an inclusion of social dimensions.

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Appendix A

Table A1. Keyword Filtering Approach.

Keywords Combination	Time	Database	Number of Articles
(fashion) AND (product) AND (process) AND (supply chain)	May 2016	Web of Science	52
		Scopus	74
(fashion industry) AND (product OR process OR supply chain)	May 2016	Scopus	232
(sustainability) AND (fashion) AND (product OR process OR supply chain)	May 2016	Web of Science	8
		Scopus	15
(sustainability) AND (fashion) AND (supply chain)	May 2016	Web of Science	39
		Scopus	38

Appendix B

Table B1. The Classification Framework: Environmental and Social Sustainability in Product Design.

3DCE Stage	Category	Aspect	Practices Implemented	References	
Product	Environmental	Materials	Use of organic cotton	[7,18,19,25,43–45,50,51]	
			Use of eco-friendly materials	[7,18,25,43,45,50]	
			Use of recycled materials (e.g., use of recycled polyester, amongst others)	[1,18,19,25,44,45,51,63]	
			Use of the “Considered Index” to compare materials	[64]	
			Use of cotton/polyester blends	[18]	
			Textile reuse	[63]	
			Use of certified raw materials	[18,44,51]	
		Environmental	Reduction of chemical components	[25,43]	
			Reduction of colours and colorants used in products	[18,45]	
		Water	Water stewardship	[19,51]	
			Biodiversity	Elimination of fur components	[45]
			Effluents & Waste	Sustainable packaging	[25,43]
		Products & Services		Cradle-to-cradle product design	[25]
				Eco-friendly product development	[25,43,45,50]
				Life cycle assessment	[18,25,43]

Table B1. Cont.

3DCE Stage	Category	Aspect	Practices Implemented	References
			Sustainability education to designers	[18]
	Social	Labour Practices & Decent Work	Manufacturing through fair trade principles	[7]
			Providing sustainable working conditions to artisans	[7]
			Providing better farming techniques to cotton farmers	[51]
		Society	Empowering women through training and new jobs	[7]
	Product Responsibility		Using no Uzbekistan cotton	[18]
			Eco labelling	[1,25]

Appendix C

Table C1. The Classification Framework: Environmental and Social Sustainability in Production Processes.

3DCE Stage	Category	Aspect	Practices Implemented	References	
Process	Environmental	Materials	Use of locally sourced materials	[7,25]	
			Scrap and toxic material elimination	[25]	
			Chemical use restrictions	[1,43]	
		Energy	Natural leather dyeing	[18]	
			Renewable energy generation	[25,65]	
			Natural tanning processes	[45]	
		Water	Rainwater harvest	[19]	
			Reuse of treated wastewater	[65]	
			Wastewater treatment	[25]	
			Waterless dyeing	[18]	
		Social	Emissions	Water recycling	[65]
				Emission reduction	[9,18,25,43,45]
	Track and trace			[1]	
	Effluents & Waste		Carbon capture and storage	[25]	
			Waste reduction	[18,25,43]	
			Reduce/reuse of textile waste	[18]	
			Waste recovery	[25]	
	Products & Services		Waste recycling	[19]	
			Process innovation	[18,25,44,65]	
			Packaging reduction	[18,25,43]	
			Product recycling	[18,19]	
		Green process design	[50]		
		Eco-labelling	[1,25,50,51]		
		Biological textile production	[51]		
	Compliance	Replacement of solvent-based polyurethane with water-based alternatives	[19]		
		Verification of sustainable manufacturing processes	[51]		
	Transport	Process certification	[1,25,50,51]		
		Decrease in the volumes shipped by ocean and air	[9]		
		Reverse logistic systems	[43]		
	Labour Practices & Decent Work	Providing a career path and better skilled human resource management	[11,44]		
Developing programs including working age beyond regulations		[11]			
Protecting female workforce		[11]			
Enabling an open book accounting		[11]			
Society		Undertaking philanthropic donations to local communities	[11]		
	Rehabilitating ex-LTTE soldiers to work in new plants	[11]			

Appendix D

Table D1. The Classification Framework: Environmental and Social Sustainability in Supply Chain.

3DCE Stage	Category	Aspect	Practices Implemented	References
Supply Chain	Environmental	Materials	Hazardous chemical elimination at supplier facilities	[49]
		Energy	Energy efficiency at supplier facilities	[19]
			The return policy to reduce energy consumption	[19,52]
		Water	Minimal impact on water resources at supplier facilities	[19]
		Effluents & Waste	The return policy to reduce pollution	[19,52]
		Compliance	Environmental certification of suppliers	[2,43]
			Traceability	[48]
			Procurement certification	[25]
			Occupational health and safety	[26]
		Transport	Transport optimization	[19,25,43,44,51]
			Use of full-load capacity	[25]
			Closed loop SC	[50]
			Rent based Closed loop SC	[63]
		Supplier Environmental Assessment	Automated logistics processes	[48]
	Supplier/partner selection based on green and sustainability practices		[43,66,67]	
	Green projects with suppliers		[43]	
	Labour Practices & Decent Work	Social	Energy and resource management system to advance environmental data collection	[51]
			Raising the problems for working conditions and improving the conditions of upstream suppliers	[2,7]
			Financial support to provide employment to young women	[2]
			Trainings on fire and safety	[25,51]
			Trainings on the Code of Ethics and ethical purchase	[6,25]
			Coaching sessions and counselling meetings	[2]
			Training and educational material for supplier	[2,6,11,51]
			Supporting local economic development through job creation in less developed countries	[2,25,51]
			Supplier development programs	[11,18]
			Supplier management	[2]
			Use of a supplier ranking system	[18]
Establishing a fair collective bargaining process between employees and employers			[19]	
Codes to guarantee collective bargaining and freedom of association, regular employment, environmental as well as socially responsible manufacturing conditions, occupational health and safety and working schedules not exceeding 60 h per week			[2,6]	
Human Rights	Compliance to Code of Conduct (based on UN Global Compact, Universal Declaration of Human Rights, UN Rights of the Child and ILO Conventions, OHSAS)	[2,18,26,53]		
	Refusing the acceptance of cotton associated with child labourers	[2,6]		
Developing initiatives to advance well being, human rights and working conditions	[6,7]			
Society	Two tier SC audit system	[6]		
	External and accredited auditors	[2,6,26]		
	Supplier audits	[2,18,25,26]		
	Disclosure of the number of factories along with the countries that violated the code in the reporting period	[6]		
	Corrective actions for non-compliance	[2,18]		
	Multilateral dialogue with the bodies, institutions, associations and communities	[2,18,19,25]		
	Monitoring sustainable manufacturing	[18,25]		
	Monitoring factory compliance	[25,51]		
	Producers of materials used are NOT covered in the monitoring programme	[53]		
	Product Responsibility	Product take-back/recycling programs	[18]	
Laboratory tests		[19,49]		

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