A Sustainability Overview of the Supply Chain Management in Textile Industry

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Abstract—The objective of this paper is to identify the general panorama of sustainability in textile industry, and an overview of sustainable practices in supply chain management (SCM) in fashion sector. This study was developed through global literature review of both aspects mentioned above. Between the findings of this paper, it is important to mention that companies and consumers in textile industry must adopt sustainable practices (both are responsible that the textile sector is the second most polluting industry in the world), it is urgent to develop new technology and changing business model strategies inside the industry; and companies should stablish a common assessing method on sustainability in the sector.

Index Terms—Assessment, supply chain management, sustainability, textile industry.

I. INTRODUCTION

This paper develops an analysis about the sustainability inside the textile/fashion industry from two fronts: first, it will be develop, a general perspective panorama about sustainability in textile industry, and in the second half of the paper, there will be executed, the analysis from the SCM and how to assess the sustainability inside the SCM and in general, in the textile sector. This means, the first part is quite general, while the second part is more technical from the analysis perspective.

At the first beginning, it is relevant to indicate that fashion is a global industry that face social, cultural and political aspects, studied from ethical working conditions, human rights, environmental issues, economic dynamics [1] and so on. The challenge of textile industry related with sustainability, consist of setting a common goal, that considers always the proper management of the triple bottom line that includes the environmental, social and economic approach [2]; and the overview from SCM, requires a proper supply chain integration (considerations into product design along with the traditional bottom line, while also improving product functionality) [3].

Achieving this objectives, requires that consumer must increase the interest in sustainability in their clothing choices, there should be an improvement of communication between fashion companies and consumers to develop a better industry; some consumers do not trust that 'ethical clothing' is genuine [4] so that is why it is important, to run

1. Real sustainable practices in the industry, and 2. Execute a proper communication strategy to allow consumers, to believe in real eco-fashion movements, and gaining commitment of clients at the moment of buying clothes.

The evidence in the sector, indicates that sustainability in fashion is not being achieved, because the model of consumption in fashion industry is unsustainable [5], so, all efforts to let companies and clients to go green in fashion, is really valuable. One good strategy of business model that can support the intention to develop a more sustainable fashion in the world, can be the adaptation of collaborative inside textile/clothing industry, the biggest challenge for executing this idea, should be to transform the current individualistic, possession-based consumer culture [6].

As it was described at the beginning of the Introduction, this paper contains information about SCM, that involves processes like client services, transport, storage, sales, production, information management [7] and so on. SCM is defined as the planning of resources (internal and external), the development of works flows with the participation of different stakeholders, with the objective of adding value to the final product or service.

II. GENERAL PERSPECTIVE OF SUSTAINABILITY INSIDE TEXTILE INDUSTRY

Fashion has some particularities in their practices, considering the behavior of producers and also consumers in this industry, aspects like seasonality and product obsolescence are connected with the perception of fashion; but there are movements inside this economic sector that sharpen those elements, for instance, fast fashion take advantage of one of the most common consumer behaviors: their decisions are largely based upon want rather than need [3], consumers used to follow the practice of "see-now, buy-now", which is influenced widely by media.

Continuing with the analysis of costumers in the fashion industry, [8] considers that even when people have a positive attitude about the sustainability approach in textile industry, it is needed to reflect that on their behavior toward sustainability practices. This idea is supported in the study of [2], who indicates that 'people are happy to talk but less happy to actually do'. Following this argument, [9] express that consumers have a relatively low priority about the carbon footprint of daily commodities.

The intention about moving the industry toward sustainability practices, requires the deep participation of clients; [10] considers that style and price of ethical clothes usually support the final costumer purchase intention, so, it is important that fashion brands which develop sustainable practices and design sustainable products, provide

information about its eco-products to motivate the preferences in the industry about this kind of value proposals. The same study, points out about the consumers responsibility in the weak sustainable position of textile industry, the product disposal of clients is one of the biggest causes of environmental impacts that this economic sector creates.

Fashion used not to be connected with labels related with sustainability credentials [3], this panorama let to understand that the value chain in textile industry, must move toward a more sustainable model; in one corner, designers should considerate conscientiously the material choice; managers have to consider wisely the use and expenditures of energy, water, avoiding toxic materials, implement smart waste management in their companies [2].

The benefits of trying to become an eco-label company in this industry are numerous, the research developed in 128 firms listed in the Pakistan Stock Exchange [11] let to understand that eco-brands have positive effects in their environmental and financial performances, they manage smarter the material costs. Stablishing eco-labels companies or products, push organizations and industries, to use environment-efficient raw materials, use less water, reduce waste, and so on.

Obtaining all the benefits showed above, requires new technical development in the way to reduce energy consumption in the value chain in textile industry, reduce in a bigger ratio the waste that factories produce, reduce the carbon dioxide and nitrogen oxide [12]; this same study, allowed to understand that setting an automatic production system, with improvements in technology, creates positive effects in production, such as: Reduction of waste, reduce allergic problem in workers, it burns less liquefied petroleum gas (LPG) as a fuel in heating appliances, so it let to decrease the carbon dioxide along other Green House Gases (GHGs) in the factories.

These kind if improvements and benefits are urgently needed in textile industry; understanding, that a key country in the global textile market, as India, has great challenges to face according with the influence and impact of this industry, [13] pointed out about some of the strongest negative impacts of this economic sector in health and environment in the subcontinent mentioned: massive and solid waste after treatment of textile fibers, rinsing of final products, as well as from dyes; wastewater can cause diseases related with ulceration of skin, dermatitis, hemorrhages, stress, and so on. Chemicals that textile industry use and waste in an unsustainable way, can block sunlight and inhibit photo-synthesis and reoxygenation of water bodies in rivers in India. This panorama for sure is not occurring currently just in India, but in Bangladesh, China, and many other textile markets around the world.

In other to analyze in a deeply way the origin of the emissions and pollute of this industry [14] identified that the scope 1 (singeing process, curing, batching, calendaring…) processes-related emissions are the greatest contributor of the total textile industry carbon footprint; biogas emissions placed the second position, followed by scope 2 processes (dyeing, printing, cutting, quilting, stitching…).

Regarding to regulations about controlling the textile industry in the objective to protect the environment, and other implications like in the social and economic field, just to present results in the textile industry in China, there have been some findings in researches: 1. There is an imbalance structure of policy instruments related to environmental protection, 2. For the environmental policy system in China, water pollution should be the key treatment objective, and 3. There are many regulations in manufacturing textile industry in China, but environmental problems are not effectively controlled at the consumers level [15].

Communication has an important role in this intention of turning to a more eco-friend industry. Consumers do not usually prioritize style and price in fashion, whereas eco-garments concepts uses to be perceived as expensive; this situation is generated, in part, because of the lacking of information about environmental effects inside textile sector [3]. Communication between fashion companies and consumers is significantly important [2], when stakeholders in value chain are provided with information about environmental effects, they are willing to change their not eco-friendly behaviors [16].

Despite corporate sustainability seems to have a positive impact on financial performance [6], some actors involved in the value chain of the fashion industry, considers that there are insufficient incentives or values for businesses to implement sustainable design strategies [2]. In addition, many companies express that adopting sustainability practices in their operations implies an increasing in costs because there are insufficient raw and subsidiary materials; and also most of the sustainable-friendly fashion products are being designed in less sophisticated way [17], this situation, creates the idea for the majority of fashion firms, that they will not earn the revenue they estimated, making the sustainability transition of operations, not attractive for those organizations.

Ref. [18] argues that companies find hard the switch toward sustainability practices, among other reasons, theses: supplier could present problems with collaboration with stakeholders, financials implications, suppliers' perceptions of assessment–based governance mechanism influenced by stakeholders, and so on. The same study, exposes that among the main strategies to reduce those barriers shown above, value chains should: 1. Strength the collaborations involvement and support between stakeholders, 2. Audits and monitoring the application of sustainable strategies, 3. Stablishing codes of conduct inside the value chain, 4. Set standards and a certification system to reward sustainability efforts.

Naturally, to receive the benefits that offer the implementation of green strategies, requires the collaboration across a wider set of stakeholders in the industrial system [6], this panorama is necessary to deliver sustainability, and consequently, to get the benefits related; a sustainable industry will never be achieved if not all the system members work on it.

In the pursuit of setting a sustainable textile industry, it is necessary to develop a complete corporate strategy, that implies auditing, planning, implementing, and impact assessing of activities designed to shift from a low-green industry, toward a green one [19]. In this scenario, is logic to try to run quantitative performance assessment of suppliers (and of all the value chain members), the problem

of this objective is the lack of standardization and transparency in sustainability reports [20], and connected with the study of these authors, even using the GRI-GR4 reporting guide, present a phenomenon: sustainability reports vary over the years for the same company and differ considerably between companies. In this way, lack of global sustainability standards, indicators and regulations makes sustainability integration especially challenging in global supply chain networks [3].

Assessment sustainability in textile industry is important for many reasons, one of them consist in the way in which companies consider how to manage risks or negative effects on environment, for example, considering the dyeing process of textiles within the fashion industry, implies to respond following this proposed process: 1. Avoid this scenario. 2. Mitigate or reduce waste, 3. Restore the damage caused, 4. Offset, and 5. Contribute to solve in a definitive manner the inconvenience [9]. Stablishing a sustainable business model, requires a strong commitment from high direction in organizations, setting procedures, stablishing objectives, all this, to achieve not only minor accomplishments [19]. It is clear: If fashion companies really want to implement regenerative sustainability, it will have to start from the source of any creation: Design [9].

Textile industry is evidently invited to change practices, considering adopting more circularity concepts inside business models, should be a smart strategy; this framework would help change the perception of clothing, from disposable article to a reused product, with increased usage time [21].

This panorama about the change of business model in textile industry, implies the inclusion of new features in the worldwide recognized canvas established by John Elkington, in his work "*Cannibals With Forks: The Triple Bottom Line*" [16]. Aspect such Data management, (de) Branding, Concept, Innovative & sustainable business models prototypes & product development (PD), Circular design & economies, should be taken into account [22]; this scenario will connect in a better way companies with sustainability.

Reinforcing the importance of adopting circularity processes inside the textile industry, the study of [23] indicates that circularity approach, and a strong collaboration environment in the industry, can provide more positive opportunities to firms; the only solution is not to adopt new technological solutions (which implies new investment), strong support between stakeholders in textile industry, can also let the industry to solve technological challenges of up-cycling materials.

It is relevant, to exposes some of the main challenges about collaborations and adopting circularity in the industry; [24] consider that chain coordination, contracting and financial mechanisms to develop those strategies, are the key aspects to take into account, in order to stimulate and organize a new panorama of inter-firms collaboration and support.

III. APPROACHES ON SUPPLY CHAIN MANAGEMENT IN THE TEXTILE INDUSTRY

Textile industry has some production models easy to identify, they go from a traditional method that consist of design - fabric weave – production – distribution – sales; and also, there can be found, a model in which the process is much more shorter and the merchandise rotation cycles are also shorter [25]. The challenge for supply chain management (SCM) in textile industry appears in guarantying that every link in the process is develop respecting the triple bottom line (social, environmental and economic).

The role of SCM is not just about managing risks once they appears, the objective is neither to react to stakeholders after violations of environmental assets, or using social risks to press stakeholders; the SCM should be working closely and in a permanent way with every stakeholder to connect the industry which is globally fragmented (many suppliers are located mainly in developing countries), there is a lack of transparency in practices; the 'distance' between stakeholders let the client to get power, and consumers impose low prices trend, and supply chain must flood wardrobes with really low prices and short rotation cycles [26], even if this implies high social (labor risks) and environmental costs; the panorama for supply chains in textile industry seems not to improve if considering the role of governments, there are governmental pressures but policies are not well designed and there is no close accompaniment. Tough panorama for this industry supply chain.

Big challenges requires smart and ambitious solutions, developing Sustainable Supply Chain Management (SSCM) seems to be a good option to solve the numerous problems the industry faces; the study of [27], indicates that in the companies taken into account for the development of the research, the order of importance for green innovation required for solving issues and risks in the industry is: 1. Economic criteria, then 2, environmental criterial, and 3. Social criteria; this is the framework of importance for managers in this study held in China, about the priorities of implementation of green innovation practices; fundamental requirement for setting a SSCM in the textile industry. Companies need to stablish a real and strong engagement in order to become more sustainable, and reduce risks.

In this order, the study of [28], suggest that the management of supply chain, has several profiles, the most basic level, consist in a Reactive Approach, this is represented for those companies that invest the minimal effort to fulfil the concept of sustainability inside their supply chain. The second is called the Proactive Approach, which consist in those efforts that go beyond compliance with existing regulations within their supply chains; and the last one, is the Value-Seeker Approach, that is the most engaged profile with sustainability, this approach is applied in companies with the highest sustainability focus in the market, developing products and services based entirely on sustainable principles.

Developing strong approaches about the sustainability management in companies related with textile industry, stimulate an easy transition toward cleaner production; in this line, [29] argues that other barriers that can appear in the way to develop a more sustainable industry, are: technical obstruction, weak top management commitment, lack of demand for sustainable products, weak governmental system that support this kind of transition,

financial constraints, and other; these observations were obtained by the referenced study, for the Bangladesh textile case, but, stakeholders around the world, can be reflect the same situation in their own countries.

Communication, knowledge management and learning processes are key aspects to consider in order to improve the SCM, if companies adopt a strong strategy toward improving their knowledge management (mainly focused on environment and sustainability principles), then there will be a natural scheme of control on their economic, social and environmental effects, and in this order, there will be an improvement of organization's performance [30]; textile and many other industries, have problems related with the information they create and consume, for instance, in textile industry, there is a general lack of information about the properties and effect of management of chemicals and the level of emissions of chemical waste in the environment [31], if the industry improve and reinforce the information management, then, the whole value chain could reduce waste or manage it in a smarter way, reducing risks and negative effects on health and nature.

To highlight the relevance of information and knowledge in the industry, [32] indicates that while Bangladesh is the world's second largest readymade garment exporter country, is the worst country ranked in the EPI-2018 (Environmental Performance Index), some of the key reasons of this situation, can be explained through the poor level of awareness of Green Supply Chain Management (GSCM), so, the improvement of knowledge management in GSCM is urgent to reduce risks, and develop a better environment treatment. Managing knowledge and information in a proper way inside companies and stakeholders in textile industry, in an integral and progressive way, is a key effort to achieve sustainability in SCM [30]. A strong and new communicative approach in the industry, can significatively improve the risks management in up and down-stream levels in the value chain [31]; So there is a pending task for organizations involved in the supply chain in textile industry: develop strong processes toward building learning organization, establish the proper environment for knowledge sharing, promote joint knowledge creation, set knowledge storage for the whole supply chain benefits, and stimulate the creation of information technology [30].

The SCM requires to be smart in the relationship between companies, [25] express that considering clusters as a good option to connect efforts and resources, to improve the performance of the supply chain; indicates that clusters are a way in which supply chains offers a new model of hierarchy in organizations, and present the perspective of a vertical integration. This kind of alliances, allow suppliers, distributers, even producers (maquilas) to have presence in any part of the world in an easier manner, in the proper moment [7], this was an analysis, in specific, for textile industry in Colombia; but also, can be applied for any country that develops cluster as a strategy to connect supply chain.

It seems to be consensus in the academic field about the benefits of clusters, this strategy allows companies in the same industry, to exploit economies of scale by sharing in a smart way the common resources; in the way companies get closer, the value chain turns more efficient in many aspects,

like for instance, in the inventory management [33], developing a cluster strategy creates benefits even to other economic industries, like for example, the tourism sector; what organizations should understand, is that competition is not between companies, but between supply chains, so applying clusters principles, is a smart way to take advantage in the market, and benefit every company on the whole.

One additional strategy to be considered to manage in a smart way the supply chain in textile industry, can be the Coo-petition [34], which consist in a supporting feature of competition: cooperation. Textile industry has a demanding situation related with low labor prices, in addition, this is a sector that is globalized, so it is logic to consider that competition inside this industry is aggressive; then, applying coo-petition as an corporate strategy, should be a clever decision [25].

Collaboration can create the perfect scenario for the right implementation of sustainable policies, and decrease the barriers about the transition toward a greener supply chain [35], the same author, exposes some of the benefits of collaboration inside industries: save resources, strengthen communication systems, and spread knowledge exchange on sustainability issues; this framework only can be possible, if the efforts are communicated internally and externally, to implement them successfully along textile supply chains [35].

In the panorama of strong competition in the textile industry, it is required for SCM, to include tools/strategies widely used currently, for instance: Logistic 4.0, Internet of Things (IoT), Big Data Analytics, Wearable Technologies, developing Just In Time (JIT) technique to reduce costs, and so on [7]. The implementation of internet and new technologies, has allow Zara (company that belong to Inditex group), to facilitate the flow of information in an effective way, with its more than 2.244 selling points distributed in more than 58 countries.

This scenario, that includes high competition, low labor price, the profile of seasonality and product obsolescence, and so on, have created a pressure inside the industry that in the case of many textile companies, do not manage in a proper way. In the way of beating these challenges, many companies do not manage properly risks connected with this kind of business; for example, Nike's child labor scandal in Southeast Asia and the Rana Plaza factory collapse in Bangladesh both resulted in serious business and brand image reputation risks [3]. Many fashion companies follow a method of outsourcing of production to lower cost countries, just this feature inside the wide net of supply chain in the industry, represent the appearance of several delicate risks for the company, and its stakeholders in the supply chain.

Textile industry has a huge economic importance in countries like India, in which, provides direct employment for more than 35 million people, this panorama requires SCM trough innovation, highlighting worker welfare schemes and new policies about compensations and good labor condition to facilitate the retain of workers [36].

Running a sustainability analysis in the SCM inside the textile industry, is complex and requires a deep analysis; for instance, the study of [37] -that compares the legging

product, between the market of USA, and Sri Lanka-, demonstrate that production emissions were much greater than transportation emissions (for both countries) which is a typical finding for product life cycle assessments (LCA); and focusing on the economic component, this case, benefits better the workers in Sri Lanka than in the USA, because Sri Lankan garment workers receive middle class wages whereas American garment workers receive lower class wages. This scenario, should be complex to understand, this study just took into account the differences between the middle-class wages in both countries, but the LCA in sustainability must consider many others elements. In here, appears an argument, for implementing strong methods for assess SCM inside the industry.

Companies in textile industry should consider implement standardized management systems, like ISO 9001 and ISO 14001, the study developed by [38] pointed out about the benefits of both standardizations protocols: While ISO 9001 improves internal processes, in specific, cooperation between organizations in supply chain; ISO 14001 creates a significant impact in environmental processes; naturally, both benefits are desirable for any company inside the textile industry.

IV. CONCLUSIONS

This study yields the following results related with the general analysis of sustainably in textile industry: 1. Despite generally companies in the industry do not develop sustainable practices, consumers also have non-sustainable practices related with clothes consumption. 2. Communication is important to create collaboration between stakeholders in the industry, and also to allow clients to improve their conscience about adopting sustainable behavior related with clothes consumption. 3. Sustainability will never be achieved in the industry, if not every stakeholder (participants in the supply chain) adopts sustainable practices in their own companies. 4. It is require to improve the assessment of sustainable performance of companies in the industry, this can permit to identify in which aspects, companies must improve, and what are those practices that requires to be upgraded or added to the business model; and 5. It can be a smart movement, if textile industry's companies, allow the adaptation of new tech, sustainable strategies like circularity, or modify the business model to a more green-fashion concept.

Related with the approaches of sustainability in SCM in the textile industry, the main results are 1. The best profile of SCM connected with sustainability is the "Value-Seeker Approach", which look for an active commitment of companies with green-fashion practices. 2. Companies inside the industry, can adopt the creation and consolidation of clusters, and develop a coo-petition strategy, to improve the state of the industry and become more competitive. 3. If the industry applies sustainable practices in its SCM, the risks of the companies involved in the sector, will definitely decrease (avoiding cases like Rana Plaza in Bangladesh). And 5. And equal as the last idea connected with the first group of conclusions, SCM must implement new technologies, smarter sustainable strategies connected with sustainability and develop a better tracking in their processes.

Among some other concluding ideas, it is necessary to highlight these:

- Consumers disposal of waste culture, is impacting also negatively the environment.
- Designing eco-labels and eco-products, improves the relation between companies and environment and it also improves the financial performance of companies.
- Companies that implement automatic production system, reduce risks, waste and damages.
- Technological investment is not the only way in which companies can adopt circularity concepts; sharing smart resources between companies, improve the transition.
- SCM should stop being considered as a tool for solving and respond to risks once they occur; SCM should be used as a powerful strategy for increasing welfare, protect nature, and increase financial results.
- All companies in textile industry, must consider communication, knowledge management, and learning processes, as serious inputs in their business management.

There is a ultimate idea connected with general sustainability, that was expressed by [3] and the author of this study is also agree: "sustainable practices must prioritize environment first, then society and only then financial performance". Fashion companies and its clients should understand that nature damages are irreparable, there is no enough trade-off in the case of death of a person; economic issues can be solved always easier than environmental or social troubles, we most always to take this into account.

CONFLICT OF INTEREST

The authors declare no conflict of interest related with this paper.

AUTHOR CONTRIBUTIONS

Natalia Navarro supported the building of the literature review, discussed and designed part of the conclusions, participated in the writing of the paper.

Juan Cruz selected the input of the literature review that we finally used in the article. As the main author, he was in charge of the global organizations and structure of the article.

We both (Natalia Navarro and Juan Cruz), approved the final version of the article submitted.

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