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Shahriare Mahmood

THE SUBSTANTIVE APPROACH FOR MANAGING DEMAND AND SUPPLY SUSTAINABLY IN FASHION INDUSTRY

UNIVERSITY OF OULU GRADUATE SCHOOL;
UNIVERSITY OF OULU,
FACULTY OF TECHNOLOGY

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Abstract

"Sustainability" is broad term that variously connects to issues in demand supply chains and beyond. The concept appears in research and practice in fragmented form to address contemporary social and environmental problems. Yet the importance of sustainable products as a part of total sustainability has not appeared in discussions of sustainability in supply chain operations. This research aims to examine the importance of product sustainability as a consideration for achieving total sustainability in the demand-supply chain management in the fashion industry. Key supply chain considerations were selected through literature review, which was used to evaluate the importance of key considerations through case studies. The case companies were selected from both upstream and downstream of the supply chain to determine the priorities at different ends. These selections, along with other key factors, are prioritized through an analytical hierarchy process. The elements of product compliance, aside from social, environmental and economical compliance, are presented in a sustainability hierarchy. A qualitative model is built in accordance with the elements of the sustainability hierarchy and the priorities from empirical studies. The aim of the model is to present the major considerations for sustainably managing supply and demand to substantively create values.

The prioritization of the practical key elements of the cases in different positions of the supply chain with discrete foci has set the balance in the assessment process. The proposed framework has the potential to be implemented by the practitioners, as it is tested in collaboration with the experts from different part of the supply chain of specific expertise. This framework has established a foundation on which to further scrutinize each element and examine their sub-elements to yield a comprehensive insight in different perspectives, advantageous for each participant in the value-creation process. As supply chains' setup and processes are highly product dependent in fashion industry, product orientation will help to guide the sustainability need to achieve total sustainability.

Keywords: demand supply management, fashion industry, product sustainability, sustainable supply chain, total sustainability

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Tiivistelmä

"Kestävä kehitys" on laaja termi, joka tarkoittaa yhteiskunnallista muutosta turvaten hyvät elämisen mahdollisuudet nykyisille ja tuleville sukupolville. Käsite esiintyy tutkimuksessa ja käytännössä hajanaisessa muodossa nykyaikaisten sosiaalisten ja ympäristöongelmien ratkaisemiseksi. Toimitusketjuun liittyvissä tutkimuksissa, ja erityisesti tekstiilien toimitusketjussa, kestävää kehitystä ei ole käsitelty kokonaisvaltaisesti. Tämän tutkimuksen tarkoituksena on tutkia tuotteiden kestävyyden merkitystä kestävän kehityksen saavuttamiselle muotiteollisuuden toimitusketjun hallinnassa. Toimitusketjun keskeiset näkökohdat tunnistettiin kirjallisuuskatsauksella ja niiden merkitystä arvioitiin tapaustutkimusten avulla. Esimerkkiyritykset valittiin sekä toimitusketjun alku- että loppupäistä prioriteettien määrittämiseksi koko toimitusketjussa. Nämä valinnat, samoin kuin muut avaintekijät, priorisoitiin analyyttinen hierarkiaprosessi (AHP) -menetelmän avulla. Kestävyyshierarkiassa esitetään sosiaalisen, ympäristön ja taloudellisten vaatimusten lisäksi tuotteiden vaatimustenmukaiset elementit. Laadullinen malli rakennettiin kestävyyshierarkian elementtien ja empiiristen tutkimusten prioriteettien mukaisesti. Mallin tavoitteena on esitellä tarjonnan ja kysynnän luomat tärkeimmät näkökohdat kestävän kehityksen hallinnan saavuttamiselle toimitusketjussa.

Käytännön keskeisten osien priorisointi toimitusketjun eri osia edustavien tapausten avulla on luonut tasapainon arviointiprosessiin. Esitetty malli on testattu yhteistyössä toimitusketjun eri asiantuntijoiden kanssa ja sillä on käytännön soveltamisen mahdollisuudet. Ehdotettu malli tarjoaa mahdollisuuden, jonka avulla jokaista elementtiä ja niiden osia voidaan tarkastella edelleen, saavuttaen kattava käsitys MISTÄ, josta on hyötyä jokaiselle arvonluomisprosessin osallistujalle. Koska toimitusketjujen rakentaminen ja prosessit ovat muotiteollisuudessa suuresti riippuvaisia tuotteista, tuotekeskeisyys auttaa myös ohjaamaan kestävän kehityksen tarvetta, jolla saavutetaan täydellinen kestävä kehitys.

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Vantaa, December 2019 Shahriare Mahmood

Abbreviations

ACCORD	Accord On Fire and Building Safety
AHP	Analytical Hierarchy Process
AQL	Acceptable Quality Level
BOM	Bill Of Materials
BSCI	Business Social Compliance Initiative
CMT	Cut, Make and Trim
COC	Code Of conduct
CPSIA	Consumer Product Safety Improvement Act
CSR	Corporate Social Responsibility
DCM	Demand Chain Management
DSCM	Demand-Supply Chain Management
DSM	Demand And Supply Management
ERP	Enterprise Resource Planning
FF	Fast Fashion
FSC	Fashion Supply Chain
GOTS	Global Organic Textile Standard
GRI	Global Reporting Initiative
H&M	Hennes & Mauritz
ILO	International Labour Organisation
LCA	Life Cycle Assessment
NGO	Non-Governmental Organisation
PFC	Per Fluorinated Chemicals
R&D	Research And Development
RMG	Ready Made Garment
RSL	Restricted-Substance List
SCM	Supply Chain Management
SCO	Supply Chain Operation
SDG	Sustainable Development Goal
SME	Small-to-medium-sized Enterprises
SSCM	Sustainable Supply Chain Management
SSCO	Sustainable Supply Chain Operation
TBL	Triple Bottom Line
UNGC	United Nations Global Compact
WRAP	Worldwide Responsible Accredited Production
WTO	World Trade Organization

Contents

1 Introduction

The fashion industry is a topic of interest among researchers for its diversity, pervasiveness and complexity in operational management. Since textiles and clothing are a fundamental part of everyday life, the industry is large (US$ 1.3 trillion), employing 300 million people (Ellen MacArthur Foundation, 2017). The fashion supply chain (FSC) mainly consists of apparel and textiles, although it extends to many other processing stages. This study particularly concentrates on apparel processing, as well as on textile processing, to a certain degree. As emphasized by both academics and industry experts, the fashion industry is heavily supply-chain driven; customer value is created by the supply network and depends on how a supply network, rather than a single firm, performs (Lion, Macchion, Danese & Vinelli, 2016). The importance of supply-chain success emanates from the need for quick turnover of merchandise in retail, as traditional FSC lead-time can be about 18 months (Jacobs, 2006).

The FSC depends on consumer demand, which is greatly impacted by unpredictable fashion trends and variable consumer need. As a basic need or for fashion purposes, even as a distinguishing feature in terms of class variation, apparel is regarded as an intimate feature of a person, both physically and emotionally. In its social aspect, apparel functions not only as an external environment for the body by protecting it or by extending its capacities, but also as a tool for non-verbal communication (DeLong, Goncu-Berk, Bye & Wu, 2013). Naturally, the fashion industry has received attention from consumers. The industry has also seen the rise of sustainability concerns and spread-out of the term ubiquitously. The positive side of the spread of values of sustainability includes raising consciousness in the wider community, whereas there also exists the possibility of misuse the term. Carter and Easton (2011) have found that sustainability has become a buzzword, both in today's business world and within consumers more generally. Companies in the FSC, especially retailers and brands, have started to consider issues of sustainability more seriously, in addition to their classic focus on economic performance. Thus, Walker and Jones (2012) have argued that these companies should also contribute to the society at large, minimize their negative impacts on the environment, and take responsibility for the behaviour of their suppliers.

Ahi and Searcy (2013) have highlighted that sustainability has been interpreted in a variety of ways, as early sustainability initiatives have focused on environmental issues. With the increased dissemination of the topic, however,

organizations are increasingly adopting the triple bottom line (TBL) approach. The TBL suggests that at the intersection of social, environmental, and economic performance, there are activities in which organizations can engage to positively affect the natural environment and society while securing long-term economic benefits and competitive advantage (Carter & Rogers, 2008). The Brundtland Report (WCED) in 1987 was the basis of three dimensions (society, environment & economy), and de Brito, Carbone and Blanquart (2008) advocated that economic growth goes hand-in-hand with environmental and social consciousness.

The fashion industry has grown rather quickly, especially in developing economies, where the main attention has been on productivity and, according to Formentini and Taticchi (2016), any of today's environmental and social issues are rooted in unsustainable patterns of economic and industrial development. However, Esfahbodi, Zhang and Watson (2016) have found that this is a concern and affect manufacturing industries both in developed and developing countries. The fashion industry is one of the most widespread and conversant in user level due to media focus. Even fashionable products are owned by consumers at all economic levels, due to their increased affordability, fast fashion (FF) and a growing middle-class population around the globe. Clothing production doubled (from 50 billion to 100 billion units) from 2000 to 2015 (Ellen MacArthur Foundation, 2017), whereas clothing utilization has decreased by 70% over the past 15 years. Conversely, the minimal training workers need in this industry provided a possibility for an unskilled workforce to easily get jobs, shifting the economic development of many developing countries, as according to Ansett (2007) apparel industry is often recognized as a stepping-stone to industrialization.

Mass production as a method used to fulfil demand for basic textiles became obsolete because of the growth of fashion consciousness among general consumers. According to Hodge, Ross, Joines and Thoney (2011), lean method creates the most value for customers while consuming least resources in designing, building and sustaining a product. The industry saw a major change with the considerable success of FF in terms of supply chain management (SCM) and product promotion. Clothing was once regarded as a necessity, and its manufacturing had a functional purpose, whereas for today's consumer, clothing is based on appetite rather than need (Brun & Castelli, 2008). The traditional method for managing the supply of merchandise evolved from efficient and cost-effective operational need, mainly to facilitate manufacturing without focusing the actual market need. However, a seismic shift occurred when products were "pulled" into the market based on actual demand rather than being "pushed" based on best guesses and forecasts (McKinsey,

2019). The necessity of demand management evolved in this circumstance. The idea of demand chain management (DCM) has been seen as a solution in the industry to increase efficiency, specifically to reduce lead-time and forecast errors by determining consumers' desires to decrease costs related to forced markdowns or stock outs (Jacobs, 2006). Consequently, maintaining the focus from both demand and supply sides has created the notion of "demand-supply chain management" (DSCM), a term that implies gaining superior competitive advantage by coordinating the demand and supply process across intra- and inter-organizational boundaries (Hilletofth, 2011).

The fashion retail industry marketplace is characterized by chronic downward price pressure, international sourcing, high product variety, high volatility and low predictability (Perry & Towers, 2013). Traditional buying has transformed from buying to sourcing practice, where suppliers are the critical element to fulfil the contemporary need for sustainability besides traditional commercial purchasing focusing on cost, lead-time etc. (Handfield, Walton, Sroufe & Melnyk, 2002; Busse, Schleper, Niu & Wagner, 2016). However, the enormous effort of managing the value-creation process has left very little attention to accommodate sustainability in the fashion industry's core production processes. The fashion industry is under tremendous pressure to reduce costs, driving of the global shift of textile-apparel production towards cheaper sources. This trend remains in force. Production in the China is no longer cost efficient, and the need for flexibility and differentiation cannot be met because of long lead-time from Asia to Western markets (McKinsey, 2018).

The chemically intensive textile industry uses thermal energy and electricity extensively, which is the major source of environmental impact in a textile's life-cycle (Sandin, Roos & Johansson, 2019). Apparel and footwear industries generated between 5 and 10% of global pollution impacts in 2016 and account for an estimated 8% (4 metric gigatons CO_2 -eq) of the world's greenhouse gas emission, where on average, a global citizen produces 442 kg CO_2 -eq for their 11.4 kg of apparel consumption annually (Quantis, 2018). Environmental challenges in textile production in emerging countries are increasing due to a lack of concern, infrastructure and regulations that are less demanding in those textile-producing countries (Tachizawa & Wong, 2014). As regulatory control is not effective enough in reducing pollution, initiatives are demanded from buyers. Many initiatives are apparent to address the social compliance issues from the brands, voluntary associations and businesses in the form of social auditing, supplier code of conduct (COC) or social programs. Tachizawa and Wong (2014) have found that leading

firms collaborate with non-governmental organisations (NGOs) and other organizations to elaborate sustainability standards, implement industry self-regulations or voluntary regulations, and monitor suppliers using third-party sources. Still, those initiatives can be considered more as good practices or voluntary initiatives.

The United Nations Global Compact (UNGC) or Sustainable Development Goals (SDG) urge responsible practice among businesses through some structured commitment and guideline, yet on a discretionary basis. National regulations are common but insufficient to solve the widespread sustainability problems in the industry. Working conditions are the concern, as many workers globally are exposed to bad or harsh conditions where visibility is lacking. The problem of overpromise of capacity is fulfilled through unregistered subcontracting where labour and safety violations occur (McKinsey, 2019). According to Walk Free Foundation (2017), 40 million people were victims of modern slavery, an umbrella term includes human trafficking, forced labour and child labour (one in four victims are children) among others. Apparel and footwear manufacturing have particular prevalence of modern slavery in countries with a weak rule of law. As in many cases the basic requirements for work place safety are not met, vulnerability remains in areas of work safety such as hygiene, machinery, and infrastructure. Moreover, the apparel industry is under scrutiny for not maintaining reasonable working hours, with long, forceable and unlawful overtime work in peak seasons and temporary layoffs in off seasons. The International Labour Organisation (ILO) convention limits the working hours to eight per day, and local regulations (e.g. in Bangladesh) limit daily overtime to two hours. Companies nevertheless force work-hour violations on their workers to meet output targets (Huq, Stevenson & Zorzini, 2014). These workers' wages are quite low, often far lower than the recommended liveable wages; even these very low wages are often paid neither on time nor properly.

Safety from harmful chemicals is another area of concern in which consumers are becoming increasingly educated and concerned. Textile processing is chemically intensive, using around 3 600 different dyes and 8 000 different chemicals in various processes, including bleaching, dyeing, printing and finishing (Hussain & Wahab, 2018). The use of harmful substances in textile production has negative effects on farmers, factory workers and the surrounding environment (Ellen MacArthur Foundation, 2017). Legislated environmental controls and product regulations in some countries compel firms to control their products and supply-chains. The rise of the popularity of various ecolabels have also been

adopted by many brands to communicate to consumers that the company values product safety or a sustainable approach (Niinimäki, 2006). Improving quality and safety standards is encouraged by society, as is greater engagement in relevant corporate social responsibility (CSR) initiatives (Haas-Kotzegger & Schlegelmilch, 2013). The assurance of products' physical safety through laboratory tests (Popp, Ruckman & Rowe, 2001) is greater way to surpass legislative limitations and to avoid risk of injury among consumers.

This research argues that the conventional approach to sustainability is not sufficient to solve the multi-faceted problems in the fashion industry. Sustainability is no longer merely good practice, but obligatory, whether compelled by regulation or stakeholders' demands. The activities usually captured by the term "sustainability" do provide solutions for this widespread sustainability issue. A comprehensive and responsible approach is required throughout the life-cycle of fashion products, where sustainability elements should be considered as systemic elements, as are other elements in SCM. The apparel industry's production impacts on climate change increased 35% (between 2005 and 2016) and are projected to steadily rise (in 2020 and 2030), and this trend would also affect all pollution indicators, from climate change to freshwater withdrawal, resource depletion, ecosystem quality and human health (Quantis, 2018). There is a strong need to synthesize elements of responsibility on both the demand and the supply side of the supply chain by integrating sustainability as a systemic property. This study explores aspects sustainability and endeavours to find priorities on both the demand side and the supply side. The findings are presented in the form of a conceptual model that considers a practical approach for sustainability.

1.1 Scope of the research

Textile-apparel SCM has attracted researchers for many years especially after industrialization, because the industry can positively impact the economy in many ways (Ansett, 2007). The industry is embraced by many different issues, which require further research to resolve. In this context, mass production appears in operational management research followed by lean production as an effective management philosophy. While mass production is useful for the high volume of standardized goods it offers, a lean system uses minimal resources to produce high volumes of high-quality goods with some variety (Stevenson, 2011), meeting the contemporary demand for variety. The fashion industry has also seen great changes in the retail commerce, as well as transformations in supply chain operation (SCO)

to adapt to globalization. Researchers have also observed the relevance of the agile paradigm, which is often considered most suitable to today's quickly changing market conditions. Agility emphasizes the demand driven concept in the industry, affirmed in the literature. Bruce and Daly (2011) have found that in the textile and apparel supply-chain, agility is appealing to reduce lead-time and to achieve quick response through careful management. Managing the demand and supply side of the value creation chain and corresponding priorities is the basis of the management study component of this research. Although agility appears in connection to demand and supply management (DSM), this research leaves out operational management in manufacturing, where agility plays an important role.

After discussing the demand- and supply-related aspects required for this research, the focus is mainly placed on sustainability, a broad topic detailed in Section 3.3. This research highlights material sustainability in its operational relationship with the DSCM. According to Carter and Easton (2011), practitioners (e.g. supply-chain managers) can positively or negatively impact environmental and social performance, for example, through supplier selection and supplier development, modal and carrier selection, vehicle routing, location decisions, and packaging choices. Typical sustainability issues often raised in the literature and noticed in industry appear in this research. Social and environmental sustainability in both parts of the supply-chain are presented, although economical sustainability is only partially considered, as this priority is obvious for every organization. Typically, consideration of sustainability issues is considered a requirement on the demand side of the supply-chain by the retailers and fulfilled in the supply side, as most of the compliance issues are related to manufacturing. In any case, addressing sustainability issues alone cannot bring the success. As Ansett (2007) found, traditional compliance models focus on the garment sector, but much CSR risk remains underneath this level of production, from the heavy use of water and in some cases forced child labor (e.g., in cotton harvesting). This research emphasizes a collaborative approach to sustainability, and responsibility should be taken by both sides. Sustainability-related challenges should be seen from a holistic perspective and through the lens of a life-cycle approach.

In general, all activities in the DSM directly or indirectly relate to and influence sustainability. Essential social and environmental compliance performance can be examined through the direct activities or indirect impacts. However, many inter- or intra-organizational operational activities are not perceivable, so cannot be assessed in terms of sustainability. In some cases, adverse impacts rather than positive impacts might be related to sustainability. For example, a failure in the quality of a

product or regulatory nonfulfillment could mean that product-rectification activities or a product recall. Generally, the product-recall process is extensive and expensive, involving a considerable amount of direct cost for withdrawal, penalty, lost sales, and so on, plus indirect costs such as loss of reputation or wasted resources. Undoubtedly, such failures directly impact economic sustainability. Recognizing product centricity, this research focuses on the product as a fundamental consideration of sustainability. It considers product compliance as a key element of 'total sustainability' which embraces product, social, environmental and economic compliance. Often, product sustainability is understood as the product having green or environmentally friendly features, (e.g., fibers and materials from sustainable sources) (Niinimäki, 2006; Na & Na, 2015; Ceschin & Gaziulusoy, 2016), but this study considers product sustainability in a more comprehensive sense: the mere use of green alternatives in a product is not enough to claim it is sustainable – other issues like quality are also critical. Quality fulfilment is basic requirement of a product, and under the wider scope of sustainability, apparel should be durable to be considered of high quality. While high quality is understood in relation to environmental sustainability, the fulfilment of general quality criteria is a basic need for financial stability. From the consumer's perspective, quality products generally have better appearances, an important feature that impacts a consumer perception of quality (Farashahi, Easter & Annett-Hitchcock, 2018).

Product sustainability must satisfy several requirements to achieve 'total sustainability'. A sustainable product is a quality product that should be produced from sustainable materials in sustainable environment by utilizing the best available technology, complying with stringent requirements by knowing the potential of recycling through the life-cycle approach. The impact on environment during life-cycle should be considered. The significance of environmental impacts in use phase could exceed that of the manufacturing phase (Kozlowski, Bardecki & Searcy, 2012), as underlined in Life Cycle Assessment (LCA) (Sandin et al., 2019). Furthermore, domestic laundering is a source of pollution, especially the impact on the marine environment through microplastic pollution and contamination of hazardous substances carried by microfibers or other carriers from textiles. The over use of the textiles is a significant source of environmental pollution through the generation of vast textile waste accumulating in landfills.

The LCA includes the extraction of raw material; production, use and final recycling; and the material in the product and the source of energy that enables the production (Ljungberg, 2007). Evidently, to produce a sustainable product, it is

necessary to have a practical approach on which a product is concurrently developed with the production methods in order to achieve a meaningful design for manufacturability, which is the pre-condition for reproducibility. Although quite a few different aspects of product sustainability are considered, the sustainability-related issues in two parts of the value chain, namely for managing demand and supply, are out of the scope of this research. This study does not include fiber or yarn processing upstream, nor does it consider the downstream-user phase or post-consumer phases. According to the aim of the study, product sustainability will be integrated in the conceptual model as an integral part of the demand-supply operations. In addition, traditional sustainability issues will also be examined in the SCOs. The important supply-chain factors will be derived from the literature analysis, which will be reviewed through case studies in order to glean the priorities of those in the demand and supply perspectives. Although many supply-chain factors appeared in the literature, this study considers only those relevant for the study, based on the literature review.

1.2 Research problem and questions

The research problem was formulated from the identification of the gaps in the research (Ridder, 2017) in SCM and sustainability in the fashion industry. The challenges related to sustainable operations evolved from outsourcing, as globalization made it difficult and less economical for companies to produce their products on their own (Gunasekaran, Patel & Tirtiroglu, 2001). The unsustainable expansion of the industry exposed many social and environmental compliance problems and human-rights-related issues. Sustainability has become an interesting subject for debate in both academic and industrial spheres (Lion et al., 2016) due to the growing concern about the negative impact created by business operations, especially in the fashion industry. The relatively new concept of sustainable supply chain management (SSCM) evolved to address sustainability-related issues in SCM (e.g. negative environmental impacts in companies' supply-chain, decent working conditions, or goods sourced ethically and fairly along the supply-chain) (Walker & Jones, 2012). According to Turker and Altuntas (2014), SSCM is the result of those concerns in the extended supply-chains in modern business operations. It highlights also the adoption of topics such as customer expectations, corporate image, governmental regulations, competitive pressures, scarcity of natural resource and so on (Esfahbodi et al., 2016). These issues have been further categorized by Ahi and Searcy (2013) as economic, environmental, social,

stakeholder, volunteer, resilience and long-term in their literature review of green and SSCM, and these scholars found that none of those studies address all of these characteristics of business sustainability or SCM. The argument is that sustainability in SCM appears in fragmented form when required, but is not considered from holistic point of view where each activity is seen as connected to sustainability. Although, SSCM considers sustainability aspects in SCOs, an overall approach for considering typical supply-chain factors and sustainability factors in the development of models and performance measurements remains absent.

Furthermore, product sustainability has not been considered a part of total sustainability and is not found in research in the form of sustainable product. The sustainable features of product are more linked to green or environmentally friendly considerations and are often regarded as good practices rather than needs. Research has been done on the importance of product quality and total quality management in the supply-chain, but not considered as part of product sustainability. According to Su, Linderman, Schroeder and de Ven (2014), operations strategy scholars have long noted the importance of establishing a competitive advantage in quality, as previous research has examined the link between quality and financial performance. Although they have emphasized product quality as a competitive advantage for sustaining business, there is a need to see it from holistic point of view. The increasing concern for product safety among consumers and the stringent physical and chemical safety regulations in force in different countries have highlighted the issue further. This study argues that product compliance and sustainability should be considered in 'total sustainability'. Product centricity will help to redefine the key factors of SCOs. The issues related to the research problem are elaborated in Chapter 3. which highlights the practices, challenges and the trends in the industry.

The main objective of this research is to emphasize the importance of the inclusion of sustainability elements in SCM for sustainable supply chain operation (SSCO). The research focus is divided into three areas (e.g. sustainability issues in the FSC, significance of sustainability in operations and managing sustainability). Considering the various issues depicted under the scope of the research and research problem, this study addresses the following research questions.

Research question 1: What are the aspects of sustainability in the evolving trend of responsibility in the FSC?

Research question 2: What are the key operational factors and position of sustainability on the demand and supply sides of the FSC?

Research question 3: What is the substantive approach to managing the FSC sustainably?

This research aims to highlight the unsustainable practices in SCO in response to question 1 and evaluates their influence in FSC to answer question 2. The propositions will be made to provide a direction for SSCO to alleviate unsustainable practices, in response to the research question 3.

1.3 Outline of the dissertation

The research divided into six chapters as depicted in Figure 1. In Chapter 2. the research methodology is presented over four sections. The choice of research method provides the theoretical foundation for the empirical research and data analysis process, whereas the research design outlines the approach for this study based on the relevant theory.

Chapter three has highlighted three different focus areas set for this study. It has first provided an overview and trend in the fashion industry and academies regarding the business practices in terms of changes and the evolution of the concept of sustainability. The DSM overview identifies an appropriate method for managing the FSC. The features of demand and supply are important considerations of the study, and hence they are presented separately. Afterwards, critical sustainability perspectives in relation to this study are offered.

After the presentation of the theoretical part, the business perspective on sustainability is given in the form of case studies. As mentioned, given the importance of having distinct view of the demand side and supply side, the case studies were also conducted from both downstream and upstream. The qualitative and quantitative data calculation and explanation are presented, and comparative analysis is made for the demand and supply side. Chapter 5 outlines the substantive approach for sustainably managing demand and supply. The model is first presented through the sustainability hierarchy. The basic organization of demand and supply are explained, offering the fundamentals of the model. The model highlights the demand-side requirements in the supply-chain and supply-side challenges. The proposition for SSCO is presented by the synthesis of both demand- and supply-side priorities, followed by the value-creation process. The thesis concludes by discussing the full study and the research's limitations, implications and reliability.

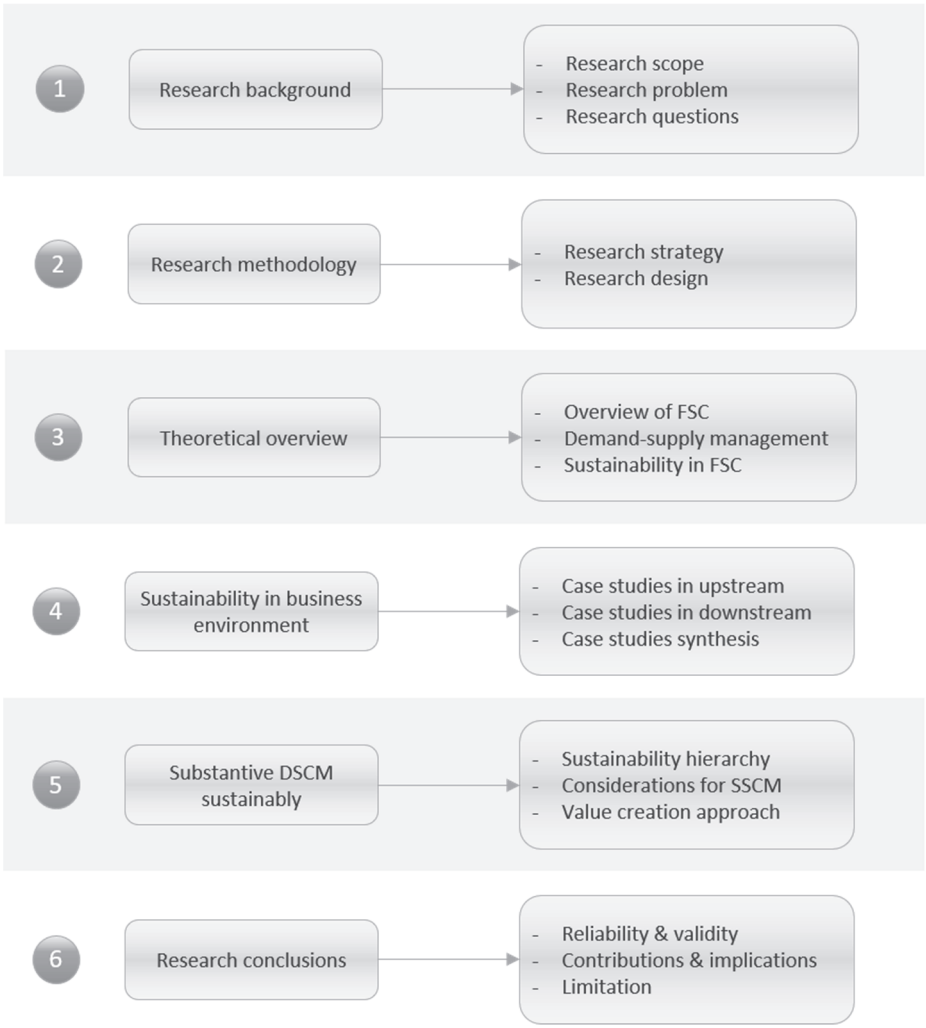

Fig. 1. Outline of the study.

2 Research methodology

This chapter presents and justifies the research methods. The nature of the research problem and the context of the industry, guide the selection of an appropriate research strategy. Amaratunga, Baldry, Sarshar and Newton (2002) state that research is conducted in the spirit of inquiry and list the basic elements of scientific research methods, which rely on facts, experience and data, concepts and constructs, hypotheses and conjectures, and principle and laws. They suggest, it is useful to define a research methodology to put the research components into perspective. The development of theory is particularly important when research embraces multifaceted issues and defragmentation of the issues.

2.1 Choice of research methods

The research problem is complex. The priority of different issues varies in different parts of the supply chain. As the intention of the study is to search for different perspectives on the problems and address the findings as propositions in a conceptual model, it is important to get a broad view of different supply-chain setups. Therefore, this research aimed to utilize the concept of studying multiple cases, where each case result provides an accumulated conclusion. According to Yin (1994), multiple-case studies accommodate different perspectives from different individual cases, which together provide perspective. The research requires a broad understanding of various aspects of sustainability on the demand and supply side of the supply chain, which requires qualitative analysis. At the same time, for the prioritization of different factors to emphasize in a conceptual model, the study also demands quantitative analysis. The following sections present the research methods to be followed in this study and the corresponding theoretical background.

2.1.1 Mixed research method

In principle, this study is qualitative in nature, as its main aim is to explore interdependences and to perceive the facts. Understanding the facts from industry perspective is significant in order to illustrate the existent situation and to build theory based on a substantive approach. Determining priorities of the supply-chain operational factors is also an important requirement of the study, in order to determine the relative position of sustainability and product centricity. Their

relative importance on the demand and supply side, as well as the weight of the corresponding sub-factors, provide deeper insights from each perspective. Such insights are critical to reduce the gap between the two sides to achieve the total sustainability. As stated by Eisenhardt (1989), qualitative data are useful to explain the rationale of the issues, which is useful in case-study research. On the other hand, quantitative research employs tools like tests and surveys and uses statistical and numerical data-analysis techniques, as accomplished through two methods: first, descriptive methods provide information about the distribution of data, and second, inferential statistics involve a set of statistical techniques (Taguchi, 2018). He further argues that quantitative methods take a confirmatory approach and are used for the purpose of confirming (or disconfirming) hypotheses, whereas a qualitative approach is exploratory in nature. Quantitative analysis is employed to analyze the causal relationships between the factors, based on the deductive approach. Quantification of the different supply-chain priorities is critical for the judgement in each case company and on the demand or supply side in general to establish the important operational priorities. Therefore, the amalgamation quantitative and qualitative research is found suitable based on the aim of the present research. According to Brannen (2005), there are more overlaps between qualitative and quantitative research than differences, as she opposes the generalization of the terms through naive notions (e.g. one uses words and focuses on meanings, while the other uses numbers and focuses on behaviors). She further argues that the use of both methods in research is possible, as both types of research may employ both forms of logic (e.g. association of qualitative research with an inductive logic of enquiry and quantitative research with hypothetic-deduction). Seaker, Waller and Dunn (1993) advocated a triangulated approach to utilize multiple methods in order to minimize method-related variance while maximizing trait-related variance. Triangulation entails a combination of methods, where weaknesses of each method are compensated by the strengths of another (Amaratunga et al., 2002). The mixed-methods approach provides greater flexibility to the researcher, yet in structured way. As Taguchi (2018) has stated, it is an effective way to pragmatically develop patterns through converging or diverging evidence, as determined by both quantitative and qualitative data.

Hurmerinta-Peltomäki and Nummela (2006) define mixed-methods research as the combination of qualitative data collection or analysis with quantitative data collection or analysis. They define four data collection phases from a methodological perspective, namely: initiation of the process before data collection, implementation of collected data, integration of collected data and collated, and

interpretation of the data to draw conclusions. Notably, 'data' is the main component of the different phases, so a data-analysis method must be defined based on what type of data are collected and how they are utilized. In their review of different data-analysis techniques in mixed-methods research, Östlund, Kidd, Wengström and Rowa-Dewar (2011) find that the majority of mixed-methods research includes parallel data-analysis techniques, specifically among three different techniques: parallel, concurrent and sequential. In the parallel data analysis, collection and analysis of both qualitative and quantitative datasets are carried out separately, and the findings are not compared or consolidated until the interpretation stage. Taguchi (2018) highlights few characteristics of data collection of mixed-methods research. Both quantitative and qualitative data are collected, either concurrently or sequentially, and secondly, quantitative and qualitative data can receive equal emphasis, or one can be prioritized over another. He also affirms that mixed-methods research requires a study to strategically integrate quantitative and qualitative data to interact in a particular way.

Interpreting the integration of data rationally is a critical part of the process. If qualitative and quantitative data are not integrated during data collection or analysis, the findings may be integrated at the stage of interpretation and conclusion (Östlund et al., 2011). In their study, Hurmerinta-Peltomäki and Nummela (2006) characterize a process of mixed-methods research in which data are collected through open-ended questions utilizing the integration phase and highlighting the timing of the combination of the two types of data. However, the research does not set limits on how data should be prioritized in different phases, although Brannen (2005) has suggested that a qualitative and quantitative approach should be considered in each phase of research enquiry. On the other hand, Östlund et al. (2011) argues that when qualitative and quantitative methods are mixed in a single study, one method is usually given priority over the other, and the purpose of mixing the methods should be clarified to explain how the findings are integrated. The present research intends to utilize a case-study method that is qualitative in nature, basing its findings on detailed analysis, where quantitative analysis of key factors provides the facts for prioritization of the activities to be included in the conceptual model.

2.1.2 Case study as research method

Case studies are a useful tool in research, especially in social sciences, but also in other disciplines. A case study presents a practical approach to investigate real-life

phenomenon scientifically within one's own environmental context (Ridder, 2017). According to Gummesson (2000), the use of case-study research is widespread in management and is also evident in SCM research. Case studies enable in-depth studies on topics with more than analysis of numbers, additionally accessing the facts behind the numbers. Welch, Piekkari, Plakoyiannaki and Paavilainen-Mäntymäki (2011) state that case-study research is a means of theorizing rather than a method of production of data analysis.

Voss, Tsikriktsis and Frohlich (2002) provide a seven-step procedure for case studies, which is followed in this research. Firstly, the case-study method is selected for the research based on the need to acquire knowledge through empirical analysis. Yin (2003) has stated that a case-study method allows investigators to retain holistic and meaningful characteristics of real-life events (e.g. organizational and managerial processes). As SCM and sustainability are two very wide areas of research, with this method the issues would be narrowed down to key focus areas at a reasonable scale for the intended theorization. Case studies allow direct observation of a field, which is particularly suitable to approach the several links in a supply chain (Seuring, 2008). Case studies can be used for different purposes (e.g. exploration, theory building, theory testing and theory extension) (Voss et al., 2002). This research aims to establish new theory through multiple-case studies to explore that theory in different FSC contexts. According to Rowley (2002), a multiple-case study with cross-case analysis reveals similarities and differences. A sustainable way to approach DSM embraces many different issues, which must be prioritized and integrated. There is also a necessity to understand the same issue from different perspectives. Through multi-case analysis, different views can be obtained, which is important for establishing consensus and in providing propositions.

Secondly, Voss et al. (2002) have suggested forming a research framework and question. The choice of case study or another method depends on the requirement for exploration based on the research aim. The definition of the research question is a key element of a case-study research (Eisenhardt, 1989; Yin, 2003) for selecting the proper research strategy. This research pursues holistically examines sustainability in various parts of the FSC, as well as the significance of product sustainability. The purpose and research questions set in section 1.2 guides the research process, where case analysis is used to pursue the second question. The model is constructed relying upon the sum of the findings. This study's findings are developed in parallel through theoretical understanding and empirical study.

As the study relies on cases, choosing appropriate cases are crucial. According to Gerring (2007), chosen cases must be representative of the population of interest relevant to the proposition. Rowley (2002) emphasizes the competence of the researcher in data collection as it is the most laborious part of the whole process and suggests following a case-study protocol to ensure proper execution of such a study. A careful sampling of cases for this research is therefore required to represent the characteristics of the demand side and supply side of the FSC. It is understandable from the analysis of the research problem that the investigation requires more on the supply side. The challenges related to social and environmental issues vary between the scale and type of the organization and the type of products they deal with. Larger organizations typically have better organization for occupational health and safety, but unable to eliminate the worker treatment related issues. Smaller firms have better reach to the employees by the top management, but often lacks compliance practice due to lack of resources and expertise. The blending of small and large organizations provides various aspects on social sustainability. Vertically integrated companies confront challenges related to environmental pollution and chemical safety. Therefore, the case companies in this research represent a combination of large enterprises and small-to-medium-sized enterprises (SMEs) in demand and supply side that are categorized into retailing and manufacturing, apparel factory only or vertically integrated textile, knit or woven products, and so forth. Chapter 4 will elaborate the various cases.

Phases four and five of case-study research, as guided by Voss et al. (2002), are the development of research instruments and the execution of field research. For data collection, this research uses semi-structured interviews based on the topics and subtopics listed (see Table 20 of Appendix 1), informal conversations, personal observations and process analysis, among other considerations. In order to verify the knowledge from literature and to evaluate the position of sustainability in different perspectives, semi-structured interview is obvious for this research. Open, yet structured discussion will provide ample information, as well as provide the possibility to verify various performance factors with scores. Gerring (2007) has stated that traditional case-study research is conducted with qualitative methods of analysis, but the methods can also be quantitative or mixed with qualitative. According to Eisenhardt (1989), both methods can be utilized where quantitative data from questionnaires with qualitative data from interviews and observations are combined. This research utilized this formula to gather ample information for analysis. The data collection and analysis method stated in depth in the following sections, as Seuring (2008) has criticized that case studies in SCM have not

clarified enough how the data was analyzed and how the rigor of the research was ensured.

Reliability and validity are particularly important for case-study research (Voss et al., 2002). For the validation of research and the study's theoretical propositions, acceptable data analysis is a requisite. To avoid any discrepancy and ascertain the study's compliance, the following chapter elaborates the data-collection and analysis methods. Eisenhardt (1989) considers this difficult task to be at the heart of theory-building from case studies. She argues that to end the process for potential development of theory requires one to limit the window of time for applicable cases as well as to stop iteration between theory and data. The final step is documentation, which is also critical to the reliability of the study. The organized approach for documentation through digital methods and hard copy of the interview data, case information, pair-wise comparison, and so on followed by the analytical hierarchy process (AHP) is the important means for reliability. It will be further elaborated in the discussion section and the AHP in the following section.

2.2 Data collection and analysis

Building theory from case studies require qualitative data analysis, which is a primary choice in this format, and data collection is based on triangulation, where interviews, documents and observations are often combined (Ridder, 2017). Case study is the main means of data collection for this research, following a method of triangulation. The data collection also includes quantitative data, where the key supply-chain factors are analyzed in each single case for prioritization. The literature review in Chapter 3 elaborates on the corresponding factors in the FSC. With the help of cases, empirical studies reveal the facts in practice and their priorities both upstream and downstream of the supply chain, which is critical, as product sustainability is the principle consideration for achieving sustainability.

2.2.1 Data collection from cases

Theoretical review sets the basis for the case studies, where different factors critical to the FSC are examined, in addition to sustainability. The correlation between typical supply-chain performance factors and sustainability is an important evaluative factor in this research, guiding the development of the conceptual model. As the priorities differ on the demand and supply side, this research considers studies both upstream and downstream. Case companies (see Table 1) were chosen

to meet the criteria for the research objectives, and they were identified based on personal contacts or through referrals. Nine cases were selected for examination in the upstream part of the supply chain, including a mixture of manufacturing companies and local branch of an international brand. Some of the manufacturing companies are vertically integrated consist of most of the operations in apparel and textile production. Typically, retailers and brands have different product categories, and suppliers are often specialized in specific product types. Hence, it was important to have a variety of suppliers in the upstream. Downstream, three companies were contacted: One had its own partial manufacturing division, one procured product through nearshore manufacturing, and one outsourced all operations from Asia. To attain a proper picture of the priorities, versatile cases were selected for analysis, and naturally, more cases were upstream, due to the greater versatility in that part of the supply chain. In summary, cases can be classified as retailer or brand, intermediary and manufacturer.

Table 1. Overview of the cases.

Case no	Company type	Position in supply chain	Company description
1	Knitwear products	Upstream, Gazipur, Bangladesh	Large setup for garment & textile manufacturing, vertical setup.
2	Denim & woven products	Upstream, Dhaka, Bangladesh	Large setup for garment & denim finishing.
3	Knitwear products	Upstream, Dhaka, Bangladesh	Large setup for garment & textile production, nearly vertical setup.
4.	Knitwear products	Upstream, Dhaka, Bangladesh	Large setup for garment & textile production, vertical setup.
5	Woven & knit products	Upstream, Dhaka, Bangladesh	Large setup for garment & embellishment work.
6	Knitwear products	Upstream, Dhaka, Bangladesh	Large setup for garment & textile production, composite plant.
7	Knitwear products	Upstream, Dhaka, Bangladesh	Medium to large scale garment manufacturer.
8	Home textile products	Upstream, Dhaka, Bangladesh	Large setup for towel production, vertical setup,
9	All apparel product types	Upstream, Dhaka, Bangladesh	Local buying office of a reputed European brand
10	Children products	Downstream, Helsinki, Finland	Internationally renowned brand, Production outsourced in Asia & Europe.
11	Children & women products	Downstream, Helsinki, Finland	Finnish brand manufacturing in Europe, mainly sold in Finland & Nordic countries.

Case no	Company type	Position in supply chain	Company description
12	Denim, woven, outdoor products (men & women)	Downstream, Helsinki, Finland	Finnish company with few own local brands, nearshore production, main market is Finland

For each case, a general analysis was made of the company, and expert interviews were conducted face-to-face using a semi-structured interview guide. The topics of discussion are presented in Table 20 (see Appendix 1). The interviewees (see Table 2) included the highest executive in a company in many cases, or at least a higher management employee with strong knowledge of the company and its operations. The objective of the research was explained to each interviewee in order to gain the best possible insight for the research and to perform the pair-wise comparison to produce rigorous results. The sessions were designed for extensive discussion that could last as long as two to three hours, as agreed upon with interviewees prior to the meeting. Interviewee also provided an overview of the company and its operational priorities, also reflected in the data analysis. The topics defined in the questions facilitated the collection of structured information, while further general discussion allowed a wider view of the case and business.

Table 2. Overview of the interviewees.

Case no	Interviewee	Meeting location	Interview date, duration & place
1	Chief Operating Officer - Garments	Gazipur, Bangladesh	15.07.2017. 2 h, Production office and manufacturing.
2	Senior Manager of Planning & Business Development	Dhaka, Bangladesh	12.07.2017. 2.5 h, Manufacturing
3	General Manager, Sourcing	Dhaka, Bangladesh	05.07.2017. 2.5 h, Manufacturing
4	Managing Director	Dhaka, Bangladesh	11.07.2017. 2.5 h, Head office
5	Group Director	Dhaka, Bangladesh	16.07.2017. 2 h, Head Office and factory
6	Senior General Manager, Marketing & Merchandising	Dhaka, Bangladesh	11.07.2017. 2 h, Head Office
7	Managing Director	Dhaka, Bangladesh	12.07.2017. 1.5 h, Head Office
8	Head of marketing	Dhaka, Bangladesh	04.07.2017. 2.5 h, Head office
9	Sustainability Manager	Dhaka, Bangladesh	12.07.2017. 1.5 h, Buying office
10	Sourcing Director	Helsinki, Finland	05.03.2019. 2.5 h, Head office
11	Director of Development	Helsinki, Finland	25.03.2019. 1.5 h, Head office
12	Managing Director	Helsinki, Finland	15.04.2019. 1.5 h, Head office

A pair-wise analysis based on the AHP was planned to be conducted with each participant to quantify the priorities in order to calculate the overall priorities of the factors. This provided the evidence of importance with respect to sustainability and product centricity as part of total sustainability. The hierarchy for the AHP is formed based on the typical supply-chain priorities, although these factors are prioritized in accordance with the needs of this research; specifically, the integration of sustainability in applied form while managing demand and supply. A discussion of supply-chain factors and sub-factors in Chapter 3 will depict the selection and corresponding hierarchy of these factors. For AHP calculation, supply-chain factors are placed in the middle layer, followed by the sub-factors of each of the other factors in the following layer. The sub-factors are also prioritized through the AHP. To achieve an overview of the sub-factors, further global weight calculation will be made to render the priorities in detail, as will be reflected in the formation of the conceptual model. The average values of the sub-factors for each of the cases in the upstream and downstream were also calculated to achieve a clearer picture of the supply side and demand side priorities.

2.2.2 Analytical hierarchy process to prioritize factors

The AHP is a widely used procedure (Sharma & Bhagwat, 2007) to simplify the process of solving complex problem to support decision making. It translates the decisions in the form of a number to simplify the process of decision making. According to Handfield et al. (2002), the AHP was originally devised by Saaty (1980), which a powerful decision-making tool to structure complex multi-person, multi-criterion decisions in business and economics based on the relative priorities assigned to each criterion's role in achieving the stated objective. A typical AHP calculation uses alternatives among the priorities to be selected, based on defined criteria. Sharma and Bhagwat (2007) explain that a hierarchy is structured from the top (managerial objectives), through intermediate levels (criteria and sub-criteria) to the lowest level (list of alternatives). According to Saaty (2008), structuring the decision hierarchy requires pair-wise comparison where each element in an upper level is used to compare the elements in the level immediately below. As he adds, making comparisons requires a scale of numbers that indicates how many times more important or dominant one element is than another with respect to the criterion or property by which they are compared. Table 22 (Appendix 3) presents the conditions used for scoring in a pair-wise comparison.

The pair-wise comparison creates a matrix by which values are compared numerically. The normalized value from each row produces the priority vector with the help of random indices presented in Table 23 (Appendix 3). The sum of the priority vectors should always be one. An advantage of the AHP is the possibility of check the consistency of the calculation. According to Sharma and Bhagwat (2007), the consistency ratio of the matrix should be at least ~10%. This study utilizes the AHP method widely in the calculation of factors and separately for each sub-factor. Global weights are calculated by the amalgamation of the sub-factors with corresponding factors. Consequently, all sub-factors were listed to find the priorities among the sub-factors. The final and global weights of the elements for the sub-factors of mid-level factors are found by adding all the contributions of the elements in a level with respect to all elements in a higher level (Sharma & Bhagwat, 2007).

2.3 Modelling and validation of concept

2.3.1 Conceptual model

This study aims to develop a conceptual model to address the described challenges in the fashion industry. It aims to theorize 'total sustainability' comprehensively, integrating sustainability into SCOs rather than addressing isolated elements of sustainability issues. The conceptual model highlights critical operational areas and corresponding activities, as well as the interlink between functions. The construction of the model begins with the collection of elements of different sustainability aspects in different areas. Those elements are compiled in the sustainability hierarchy in different layers, depending on the merit of the topics. Notably, the hierarchy includes product-sustainability elements in addition to the typical social, environmental and economic elements of sustainability. The purpose of the sustainability hierarchy is to depict different elements according to their levels of importance; these elements are then used thematically in the conceptual model. The strategic and planning-level elements are naturally seen in the downstream part of the supply chain within the focal company. Typically, a brand company or retailer leads the supply chain, due to its competitive advantage as buyer, allowing it to bring the non-financial requisites to the suppliers. The supply side, on the other hand, incorporates operational elements, as the implementation

of the plan corresponds to the suppliers. The theme behind the sustainability hierarchy has been elaborated among scholars (Mahmood & Kess, 2018).

The thematic model will be composed of the priorities achieved from the empirical study. The priorities are calculated from supply-chain factors and sub-factors through an AHP from both the upstream and downstream cases. In addition to ascertaining the importance of product sustainability, the calculation will also reveal different top sub-factors on both the supply side and demand side, where operationally critical activities will be accommodated in the model. Priorities are likely to differ between the demand side and the supply side. The case analyses will also determine the important activities for sustainable operations. The thematic model will include the propositions from the calculations and information from the studies in order present a substantive approach for the sustainable management of demand and supply.

2.3.2 Focus group

The research aspects and conceptual model for the substantive approach to sustainable DSM were discussed with a group of experts through focus-group discussion. Although the concept was verified with the research community to some extent, the applicability of the concept demands verification in the industry. Focus-group discussion is a practical approach in such circumstances, as Edmunds (1999) states that it is used as a means of testing new concepts as a part of qualitative research process. The research approach and conceptual model in this study are shared with industry experts, following the stated method. The design of the focus group follows the process described by Edmunds (1999), as elaborated below.

The focus group study begins by setting a research objective. The main aim is to share the conceptual model with industry experts to get feedback and their view. As the study focuses on the substantive approach, it is important to validate whether the concept is aligned with the industry need. Therefore, it was important to recruit appropriate members for the focus-group discussion, those with knowledge from the industry. Certain aspects were considered in choosing the members for the discussion with knowledge of all or one of the areas (e.g. practical experience with apparel products and operational practices, knowledge of sustainability, knowledge on impact of sustainability in the fashion industry and the typical challenges of this industry both in the manufacturing supply chain and at the use phase). The group consisted of participants (see Table 21 of Appendix 2) from both the demand side

and supply side of the industry, and consumer representative for ensuring the inclusion of critical views of sustainability from consumers. As this study models activities or propositions as connected to downstream and upstream, it is critical to solicit responses from both side experts. The focus group was formed of two members from the supply side and three from the demand side, among which one was specifically to provide insight into consumers' ideas of sustainability. The forum was set to discuss the applicability of conceptual model and corresponding proposition, so that participants could share their points of view on whether the model fits in rectifying the challenges they live with in their niche. The limitations of the model were also expected to be identified from the discussion.

According to plan, potential members would be contacted via phone and email, and the research overview would be shared prior to their acceptance for the participation. The focus-group discussion will be flexible, as participants could take part in person or participate via Skype. Online access is important, as overseas participants from the supply side also will take part in the discussion. The session is planned to be two-hours long and will be recorded, with the consent of participants. The researcher's role is as the moderator of the session, explaining the background of the study and the approach of the conceptual framework. A presentation of the contents for both direct and online participants will be provided with the same information. Each participant will share their views on the model and will comment on it. Notes from the key points of the discussion will be rectified in finalizing the model. After the discussion, the moderator formally concludes the session by reminding participants of the key discussion points.

The focus-group discussion is a significant part of the research, and hence it is critical that the participants comprehend the framework and logics behind the construct. As the aim is to verify the model in practice, the moderator must describe the process clearly in structured way. Table 3 describes the main focuses of the focus-group discussion. The analysis of focus-group data is an important part of the process; according to Breen (2006), this analysis should include the most important themes, noteworthy statements, and unexpected findings. The verification of the concept of product sustainability and the conceptual model are a critical part of the research, so it is very important to derive clear understanding of the discussion. Findings will be further discussed during conclusionary discussions.

Table 3. Issues and explanations of focus-group elements.

Issues	Explanation
What research problems are offered to the focus group?	The aim of the research was to integrate product considerations into total sustainability, which would be regarded as a supply-chain factor aside from other typical factors, through developing a framework highlighting the major activities.
What is the aim of the focus-group discussion?	The aim is to verify the conceptual model in the industry in order to reduce the gap between the demand and supply side from sustainability viewpoint.
Why focus group?	Focus-group discussion is an effective way to test a model in which experts can provide feedback by direct interaction and the researcher can further clarify if consensus is not attained.
How have the members been facilitated and groomed?	Background information to be provided beforehand. To obtain the best input from the participants, the research problem and approach will be explained prior to the discussion. The expectations of them will be explained too.
What were the expectation from the model which intended to be realized?	The conceptual model should be able to address the practical operational problem. It should apply to both the demand side and the supply side It should apply irrespective of geographical location. It should be clear enough for operational managers from both sides. Industry experts must find it logical and useful.
What information to be searched from the focus group?	The practical view of the findings from demand-side needs, supply-side challenges, the importance of product sustainability, and the integration of total sustainability concept in the SCM.
How will the focus-group information be utilized?	The information obtained from the focus-group discussion to be used to cross-check and update the propositions in the conceptual model.

2.4 Research design

Planning is a significant part of any study, and by acknowledging its importance, this research is formulated constructively. A research design links the data requirements for the study to the research questions that drive of any empirical study implicitly, if not explicitly (Yin, 1994). Ridder (2017) states that a research design is a plan of action for an entire research process, from questions to conclusions, which ensures a clear view of what is to be achieved from the case study. A research design has components such as follows: a study's questions, propositions, units of analysis, the logic linking the data to the propositions, the criteria for interpreting the findings, and so on (Yin, 1994; Ridder, 2017).

The research design for this study is depicted in Figure 2. As similar to many other studies, it has started the definition of a research problem by identifying research gaps. In order to explore the research topic, a review is offered to comprehend the problem from the literature. The case studies provide further practical understanding of the research problems and corresponding priorities and challenges. The theoretical insights and industry practices are the basis of the construction of the conceptual model, as is further validated through a scientific approach.

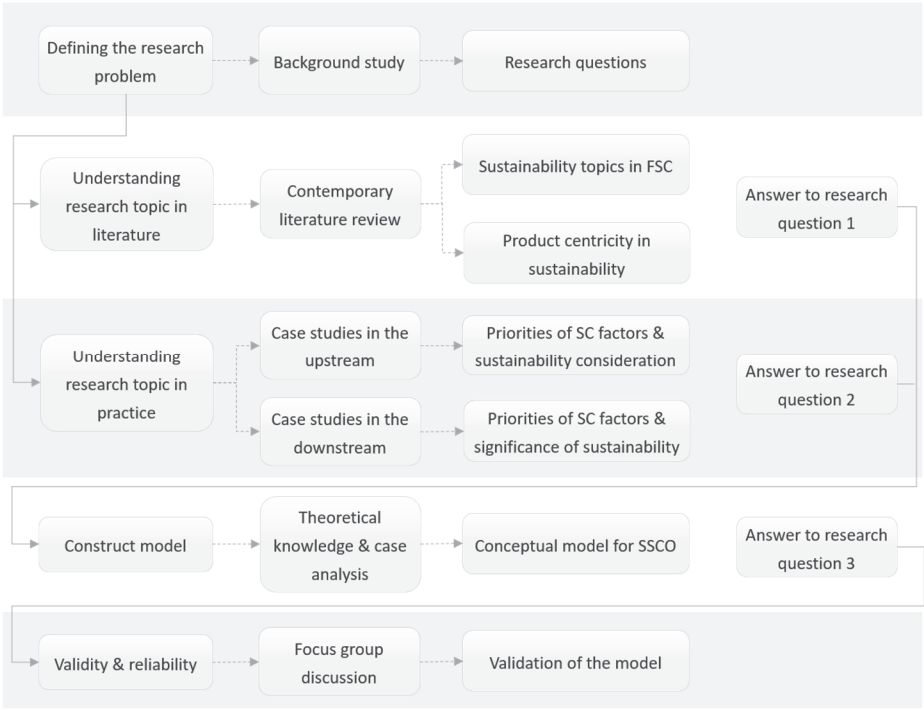

Fig. 2. Research design.

3 Theoretical foundation

This chapter provides the theoretical background of the research. The literature review focuses on three distinct themes. The first part of this chapter will provide an overview of the fashion industry and FSC. The second part will highlight the management methods of demand and supply. The third part of the literature review will focus on sustainability in context of the fashion industry. The main aim of the review is to comprehend the crucial supply-chain factors from the perspectives of both demand and supply, given present business trends in the fashion industry. The study also reveals the significance of sustainability both downstream and upstream, as well as finding the role of product sustainability.

3.1 An overview of fashion supply chain

"Fashion" is a broad term encompassing an element of style likely to be short-lived, and the fashion market has characteristics such short life-cycle, high volatility, low predictability, high rates of impulse purchasing and so on (Christopher, Lowson & Peck, 2004). The fashion industry has evolved as a global industry that was traditionally a cottage industry, usually in the form of handicraft and tailoring to fulfil basic need. The growth is the result of the industrial revolution in 18th century, the continuous advancement of industrialization and the sophistication of technologies to improve the quality of life (Na & Na, 2015). The evolution of the industry influenced the increase of consumption, which has broadened the industry. Barnes and Lea-Greenwood (2010) have found that consumers have become increasingly fashion savvy and interested in fashion due to the growth of media coverage of fashion. In addition, Zhang, Kong and Ramu (2016) have noted that the value addition of the clothing sector a growth spike from US$ 4.2 billion in 1980 to US$ 140 billion in 2008. offering a sense of the upsurge of the industry. The international fashion market was based mainly on few brands and located primarily in Western countries, but it has extended to developing and emerging economies such as China. Presently, China is not only the largest apparel manufacturer and exporter, but also the second-largest apparel-consumer market in the world (Chi, 2015); it may even soon become the top country, as it is the world's fastest-growing consumer market, accounting for more than 18% of all final goods consumed (McKinsey, 2019).

Fashion, which was limited to a certain class, has reached a wider community, due to its affordability and the rise of FF. The increase of the fashion dependency

of the industry made the market volatile. Furthermore, by nature, the industry is highly seasonal, increasing further the uncertainty in the business. According to Christopher et al. (2004), the fashion market is both competitive and volatile, demanding the continuous refreshing of products through the extension of the number of seasons. The FSC is widespread and dispersed into many locations as a result of global shifts. The use of textiles in many other sectors has made the industry even more extensive. The supply chain is complex, and its formation depends on the intended product type, functionality and properties. Different processing steps in the supply chain depend on product design, technical properties and requirements, quality or performance level, sustainability requirements, and so on. Material and product type also guide the location of manufacturing, as the sources of different types of yarns and materials are aggregated in different part of the world. Nevertheless, apparel manufacturing is rather widespread, and labor-intensive apparel industry is always in search of cost minimization, as cost minimization, according to Taplin (2014), typically drives competitive success for these firms. Moore, Rothenberg and Moser (2018) have found that although cost is the main driver of offshoring manufacturing, companies have also realized the importance of product quality, the protection of human labor rights, the skills of the workforce and so on. Often, the challenging social structure and lack of governance of those areas create worries about workers' rights and hence social sustainability. Contrarily, chemically intensive textile manufacturing is always a concern for chemical safety and environmental sustainability. Chemical safety is also observed as a rising trend, as people are generally more aware of problems related to environmental pollution and chemical contamination in environment (Romano & Vinelli, 2001). The fashion industry suffers from an increasing trust deficit, especially among consumers, due to the lack of strict environmental regulations and control of environmental safety. This trust deficit has resulted increasing demands for transparency (McKinsey, 2019).

While sustainability is in focus for the FSC, agility is another rising issue that has impacted SSCO. The need for agility emerged mainly from FF culture, where merchandise is required to put into market or replenish in very short interval (Bruce & Daly, 2011). The supply chain is often dominated by the focal company, which is usually a brand or retailer. The clothing supply network is usually buyer-driven, where typically a retailer in a developed Western economy works with manufacturers from a less-developed economy to supply a particular type of garment (MacCarthy & Jayarathne, 2013). The FSC can be considerably long, depending on product, and it could consist of operations in different countries or

regions. The global presence of the textile industry due to different locations of different production stages (e.g. fiber produced in a different location than for spun-to-yield yarn, which might be woven in a different country and further sewn to another country before shipping to various locations) (Seuring, 2004). As Niinimäki and Hassi (2011) state, value creation through consumers' psychological wants and emotional desires enables customers to engage in influencing production and consumption to decrease the environmental impact of the whole system, thus creating environmental value and moreover sustainable development value.

3.1.1 Formation of the fashion supply chain

The fashion industry is extensive, and its supply chain is long, spreading to many sub-processing stages in different tiers. Seuring (2004) has argued that the presentation of the textile supply chain often neglects the multiple side lines (e.g. chemicals in production or sewing yarns). He divides the production and use phases into six stages between product design in the beginning and the recycling or disposal phase at the end: fiber production, yarn and fabric production, fabric dyeing and finishing, clothing production, selling or distribution, and use. Largely, the chain can be divided into the demand chain downstream and the supply chain upstream. In general, the entire chain is divided into the demand chain and the supply chain based on the position of a decoupling point in common practice (Mahmood & Kess, 2018). The demand side of the chain manages the demand-creation process and the supply side handles the tangible value addition process. Hilletofth (2011) has shown that demand processes include market intelligence, new product development, branding, marketing and sales, whereas supply processes consist of sourcing, manufacturing and distribution. Typically, Western retailers and supermarkets have controlled vast networks of suppliers dispersed throughout the world (Lund-Thomsen & Lindgreen, 2014) that create the designs and conduct research and development (R&D). The sales and marketing of the focal firm practically generates the sales that are handled by the buying and sourcing function. Kozlowski et al. (2012) have found that design in the fashion industry includes product management and development, sales and marketing, operations and finance, and business management. Depending on the size of the company, sourcing has a great role in leading the supply chain in sustainable manner beyond mere buying activities. Ansett (2007) has found that the need for sustainability is recognized by the industry, addressed through supplier COC, supply-chain sustainability-performance improvement programs, transparency through social

responsibility reports and collaboration with stakeholders' (e.g. NGOs, companies, and trade unions). Sourcing as a part of supply-chain organization comprises the junction between the demand and supply side, and it is in the position to bring the sustainability requirement aside from other operational and commercial requirements to the suppliers. Figure 3 represents a typical textile-apparel supply chain in which only visible key players are included.

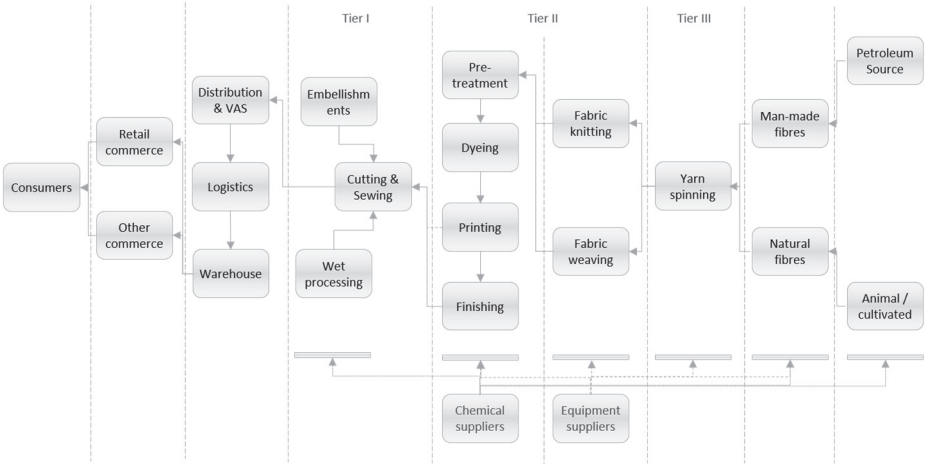

Fig. 3. Textile-apparel supply chain.

The supply side is rather long and deep, engaged in a tangible value-creation process. Romano and Vinelli (2001) have argued that SCM has developed into a concept with a broad span of concerns and a holistic approach to management across company boundaries, where purchasing and supply, as well as physical distribution, relate to only one part of the whole supply network. According to them, the upstream-network supply side consists of tier-I and tier-II suppliers. Commonly, a tier-I company is the main supplier that produces the final apparel or other textile product for the retailers (Yadlapalli, Rahman & Rogers, 2019). Tier-I suppliers are vertically connected to the tier-II suppliers for materials and components, and otherwise, the supply chain is often quite deep and not visible in a typical FSC setup. In this study, textile processors are considered tier-II suppliers. As sustainability is the prime focus of this study, it is important to understand what operations consists in each tier, especially in tier-II and beyond. Tachizawa and Wong (2014) have mentioned that the most serious environmental and social issues

in the supply chain generated by the suppliers in tier-II and beyond, which they deem lower-tier suppliers, often remained out of reach the of the lead firm. In each tier are several suppliers connected to the principal company to provide raw materials or services with specific competence. Therefore, sub-contracting is commonplace in the supply chain. Xiao and Jin (2011) note the common practice of using subcontracting to meet capacity or lead time, which is a concern from a transparency point of view, according to Lund-Thomsen and Lindgreen (2014). Tier-I suppliers, mainly apparel producers, are categorized according to their expertise for specific product types, primarily expertise developed on an available material type in a specific region. In addition, the component suppliers are also important contributors in the value-addition process.

Textile production in tier-II consists of many different steps, largely depending on the final properties of the material. According to de Brito et al. (2008), the textile industry consists of fiber, yarn and fabric production to produce clothing, interior and home textiles and technical textiles. The fiber, yarn and textile processing and manufacturing phases include washing, pre-treatments, dyeing, spinning, application of finishes and weaving. These phases are commonly divided into dry and wet processing. According to Franco (2017), dry processing includes yarn manufacturing, fabric weaving and knitting, whereas wet processing includes fabric preparation (desizing, scouring, bleaching and mercerizing), coloring (dyeing and printing), and finishing (i.e. functional finishing such as durable press, flame-resistance, water repellence). The pre-treatment process is done to remove impurities and to modify existing fibers in order to impart the desired aesthetic or functional properties before the dyeing process, which is the aqueous application of color to the textile substrates and mainly accomplished through the use of synthetic organic dyes, frequently at elevated temperatures and pressures (Parisi, Fatarella, Spinelli, Pogni & Basosi, 2015). Often, processing steps continue after dyeing, including printing or other treatments (e.g. durable water repellent or ultraviolet finishing). Fabrics are typically formed through knitting or weaving. Preparatory activities like warping and slashing are usually handled by the same factory. By these processes, yarn becomes raw woven fabric (known as “greige”) by being warped followed by being weaved (Alkaya & Demirer, 2014). The knitting also follows much same procedure. Printing can be done by the dyers, although it is common to find a specialized printing house for different kinds of printing techniques. Print quality directly influences final product quality.

Technological advancement in the textile industry occurs mainly through equipment and dyes-chemicals manufacturers. Textile dyes and chemicals are an

indispensable part of textile processing. Depending on the dye-fiber system, a range of chemical auxiliaries may be required in the dye-bath in order to promote interactions and to facilitate homogeneous fixation of the dye on the textile substrate (Parisi et al., 2015). Textile processors often need close cooperation with those suppliers in order to introduce new features and resolve issues.

This study locates yarn processing in tier-III, although it might be considered in tier-II in some cases. Regardless, it is another technology-intensive part of the textile supply chain, and processing technology greatly depends on fiber types, mainly divided into man-made and natural fibers. Man-made fibers are typically made of natural and synthetic polymers. One major synthetic fiber, polyester, accounts for approximately 51% of global fiber production (Textile Exchange, 2018). Polyester is produced from petroleum, a major source synthetic polymer, and polyester is made through polymerization chips (Seuring, 2004). He explained that the chips are melted and forced through spinneret holes to produce filaments, after which the extruded filaments are collected into thread forms.

Among the modest resources of synthetic yarn producers, China accounts for approximately 72% of global polyester production (Aizenshtein, 2017). China also produces the second-largest share (22%) of cotton, behind India (23%) and ahead of the USA (16%) (Hughes, 2019). Among animal fibers, wool accounts for 1% of the share of global fiber production (Textile Exchange, 2018). Apart from yarn processing, many components are used in apparel processing. Some of the component manufacturing is quite innovative and extensive, but limited to only a few sources. Embellishment work is a common need for fashionable products, requiring specific expertise. For instance, laser engraving used to produce very specific designs in different kinds of material (Yuan, Jiang, Newton, Fan & Au, 2012), whereas the technology is nowadays quite commonly used to precisely cut materials. In all the three of the mentioned tiers, many small suppliers have played an important role, some of which are quite specialized in their expertise. For instance, MacCarthy and Jayarathne (2013) have shown the presence of external embellishment service providers, quality auditors, and subcontractors in the supply network. Tier-I suppliers tend to integrate some of the processes vertically to achieve competitive advantage. They have a role in dispatching the readymade products and might offer logistics-provider services. In the supply chain, retailers may have distribution centers for further value-addition service.

3.1.2 Trends in the fashion industry

The textile industry has a long history in different parts of the world, as textile and apparel production are common in almost all regions, to some extent. Although apparel manufacturing is concentrated in some Asian countries, the industry as a whole considerably diffuse, mainly for reasons of cost competitiveness. The less fashion-sensitive consumers of the past (Bhardwaj & Fairhurst, 2010) at some point became more fashion conscious, as apparel is no longer regarded as merely satisfying basic needs. The rise in fashion affordability in different developing economies increases demand for fashion products, which has contributed to the diffusion of the supply chain. Simultaneously, consciousness on sustainability have also been, rising as consumers are now more rational. Moreover, regulations are becoming stricter with respect to different social and environmental issues, as well as product compliance. There are increasing demands for ethical and sustainable practices among consumers. Clothing is worn by all and the industry is familiar to the masses. So, any rising issues reach to the people quicker than other industries.

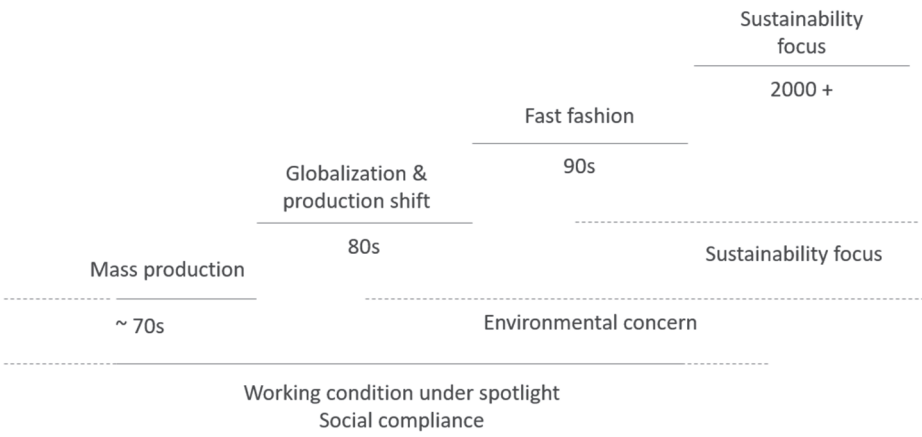

Fig. 4. Trends in the fashion industry.

Bhardwaj and Fairhurst (2010) have highlighted three areas in the evolution of the fashion industry trend, especially in supply chains. Those issues are the shifting of mass production from standardized styles to fashionable ones, the introduction of mid-seasons and the increase in their number, and structural changes from product-driven to market-driven, outsourcing for cost savings, quick responses, and so on. Figure 4 depicts a generalize trend in the changes in the fashion industry, where

major changes from the 70s are shown through the shift of mass production to globalization, the evolution of FF and the increase of consciousness and a sustainability focus.

Global shift in manufacturing location

Globalization has made major impacts on all commodity supply chains, particularly since 1990 (Tyler, Heeley & Bhamra, 2006), and the trend of outsourcing has an impact on increasing complexity in the supply chain (Hutchins & Sutherland, 2008). The apparel industry is usually labor intensive (Taplin, 2006), and the rise of labor costs and a trend of higher consumption of fashion products has pushed the industry to low-cost production areas (Niinimäki & Hassi, 2011). According to Shelton and Wachter (2005), outsourcing is driven by the desire to reduce costs and the need for business flexibility to respond quickly to changing markets. The possibility of utilizing unskilled workers in apparel production and the ease of developing workers' skills for this purpose allows the Western companies to take such strategic steps. Moreover, the apparel production setup does not require large investment, and as stated by Taplin (2014), the industry is the preponderance of SMEs with low entry barriers. The trend is continuing with the need for a shift of production to cheaper sources than China, due to the increasing labor costs in that country. Zhang et al. (2016) have found that while low labor costs have been and remain a major stimulant of the production shift, rising wages have driven clothing firms to shift further (e.g. from China to Bangladesh and Myanmar). Textiles has always been a more capital-intensive industry (Taplin, 2006), which naturally slowed the pace of the shifting of textile production. A shift of textile production near to apparel-manufacturing areas for cost efficiency and lead-time reduction is also not uncommon.

According to Mahmood, Kropsu-Vehkaperä and Kess (2017), the trend of shifting production facilities was taken as an opportunity by certain Asian countries at early stages of the momentum in the 90s to grow Asia as a major apparel exporter. Export data from the World Trade Organization (WTO) (2019) shows that the exports of major Asian exporters of apparel grew by 209% from 1990 to 2000 and by 181% from 2000 to 2010. Whereas, overall export growth of Asia was 119% from 2000 to 2010. Growth has continued, with a rate of 41% in 2017 from 2010. Africa is seen as an emerging exporter of apparel, as they had a decent growth (33%) from from 2000 to 2010, although the growth was negative (−1%) from 2010 to 2017. Still, Asian exporters maintained decent growth in the same period, as

presented in Table 4 and shown graphically in Figure 5 of the top manufacturing exporting countries, according to the WTO (2019).

Table 4. Export value in million US$ by top apparel exporters at present (WTO, 2019).

	1980	1990	2000	2010	2015	2017
China	1625	9669	36071	129820	174573	157464
Bangladesh	2	643	5067	14855	26603	29213
Viet Nam	0	0	1821	10390	21948	25037
India	673	2530	5965	11229	18168	18313
Turkey	131	3331	6533	12760	15121	15088
Indonesia	98	1646	4734	6820	7593	8214
Cambodia	0	0	970	3041	5938	7188
Pakistan	103	1014	2144	3930	5023	5470
Malaysia	150	1315	2257	3880	4800	5078
Sri Lanka	109	638	2812	3491	4772	4988
Thailand	267	2817	3759	4300	3710	3563
Mynmar		12	800	337	978	2435

China remained the top exporter despite seeing an 9.80% decline in exports from 2015 to 2017. Turkey and Thailand also showed negative growth, while all others had positive growth. Bangladesh is continuing to grow and remains the second largest apparel exporter, after China. Myanmar grew significantly (149%) from 2015 to 2017. with a similar level of growth (190%) from 2010 to 2015. It seems that they will remain a top choice, followed by Cambodia (21.05%) and Vietnam (14.07%). Pakistan (8.90%) and Indonesia (8.18%) have a reasonable growth, although the growth has dropped for both countries. Sri Lanka (4.53%) and Malaysia (5.79%) shed a considerable amount of growth. Bangladesh and Vietnam show decent growth. The shift of sourcing locations helped Myanmar and Cambodia to accumulate production facilities. Although Africa is expected to continue to grow, the concentration of apparel production will remain in South-East Asia, as seen in the trend. The major textile manufacturer, China, is one of the factors in the shift as material lead time is one of the decisive factors for apparel-manufacturing locations. Some shift of material manufacturing, especially for the technical fabrics, has been seen from China to Vietnam, but that was not enough for fulfilling the demand. Denim production can be found in different parts of the world, including South America, Turkey, and so on. For apparel manufacturing to grow in the other parts of the world, including Africa, material lead time must be

reduced. As textile manufacturing requires high investment and know-how, the change is not expected as rapidly as it occurs in apparel manufacturing.

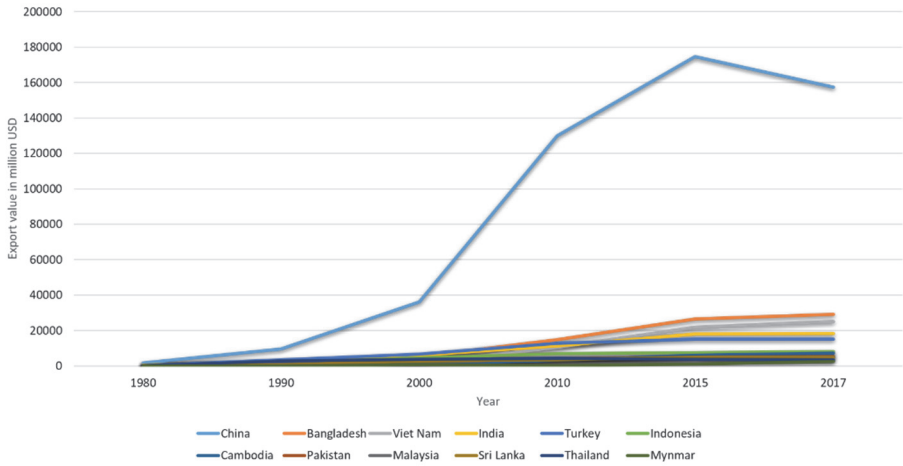

Fig. 5. Apparel export trend of the top apparel manufacturers, data from (WTO, 2019).

Fast fashion as market changer

The fashion industry has seen many changes in recent decades, especially since the global shift in the 80s. In the early-90s, retailers began to focus on responsiveness to new fashion trends rather than cost effectiveness through mass production (Bhardwaj & Fairhurst, 2010). According to them, in order to be profitable, fashion apparel retailers must take the "speed to market"' approach to capitalize on fashion not in the stores of their competitors. The inspiration comes from fashion shows and catwalks, which are no longer inaccessible for common consumers. This accessibility allows the consumer to display some of the latest fashion trends in an affordable manner, motivating the concept of FF. According to Taplin (2014), technological innovations and improved channel integration have provided the logistical means to justify the supply chain through shortened turnaround times. The idea has been captured by certain forerunning firms, matching supply and demand, as the opportunity is aligned with changing consumer behaviors and perceived as future business scope.

Tokatli (2008) has listed five requirements for FF success: increased presence in as many areas as possible to reach consumers: highly responsive communication channels to connect consumer demand to the supply chain, agile development processes with test batches, fast and highly responsive supply chains, and good performance on the stock markets. The three middle requirements comprise the phenomenon of the agile supply chain, which is increasingly the trend in the fashion industry. Mehrjoo and Pasek (2016) describe a FF apparel supply chain that deals with the perishability phenomenon, short product life-cycle, highly volatile market demand, low predictability, high rates of impulse purchases and high levels of price competition. Successful FF retailers can master their supply chains considering those key criteria, yet through distinctive setup. Agility is the main philosophy to accommodate the need of refresh the stores in shortest possible intervals.

The FF approach was successful in drawing the attention of wider consumers and made fashion widespread in affordable way. According to an Ellen MacArthur Foundation (2017) report, clothing production has approximately doubled in past 15 years (2000–2015) mainly due to a growing middle-class population around the globe and increased per capita sales in mature economies. They have attributed this growth the rise of the FF trend, with quicker turnarounds of new styles, increased numbers of collections offered per year and lower prices. The increasing trend of clothing production has mainly been due to the increase of purchasing tendency, which does not represent an actual increase of clothing consumption (Ellen MacArthur Foundation, 2017). The increasing distinction between purchase and utilization leaves much unutilized clothing, resulting in the growing problem of textile waste. Furthermore, the use of natural resources in textile production has increased significantly, especially for non-renewable resources for synthetic materials.

Price competition among the retailers (Tyler et al., 2006), especially FF retailers, also imposes pressure to reduce production costs, resulting in lower quality (Popp et al., 2001). This tendency has a direct impact on the length of product life (Niinimäki & Hassi, 2011). Products of high fashion also carry high risk, which could lead to increases in unsold products, which are common in retail industry. The unsold products produce waste, which is incinerated or put into a landfill (WRAP, 2017). The ever-increasing trend of textile waste is a problem likely to increase in severity in the near future. Aware of this problem, FF brands have made considerable effort to mitigate it, especially through the use of sustainable raw materials. The effort to utilize recycled material is a good initiative to reduce the waste, but it is insufficient, given the scale of the problem.

An impact on supply-chain practices has been felt because of the trend of FF. Barnes and Lea-Greenwood (2010) have argued that improving responsiveness through the effective management of supply chains is key in the context of FF, where popular supply-chain concepts (e.g., just-in-time production, agile supply chains, quick response, demand chains, and so on) are introduced in order to improve the ability of companies to react according to a trend's needs. Although enabling these concepts improves the required responsiveness, doubt remains in the sustainability of the approach. Bhardwaj and Fairhurst (2010) have advocated the merits of outsourcing, although expressing the concern that it might lead to (1) significantly longer lead times, (2) complicated supply chains due to geographic distances, (3) inconsistency and variability in processes at both ends of the chain, and (4) cost savings reliant on outsourcing manufacturing to low wage nations. The cost savings are sometimes significantly low compared with the cost of obsolescence, forced mark-downs and the costs of carrying inventory.

Sustainability focusses on rise

The FSC is particularly sensitive to sustainability due to its inherent characteristics and due to certain trends (de Brito et al., 2008). The homogenous growth of purchasing and the FF trend have exposed certain unseen challenges of greater interest to the industry at present time. According to Niinimäki and Hassi (2011), developments in the textile and clothing industry have focused mainly aspects of technology and cost to keep the final product price low and to increase efficiency, but the need for decent working conditions or to mitigate environmental impacts has been overlooked. Typically, developing countries are characterized by having a lack of government enforcement of national and international labor laws, due to resource constraints, lack of infrastructure, the fear of losing foreign direct investment and corruption (Ansett, 2007). The conscious-consumerism movement by activists has often exposed those issues. According to de Brito et al. (2008), some sustainability initiatives are the result of the pressure from NGOs, which have targeted the fashion industry to push for better working conditions and less environmental impact.

Carter and Easton (2011) have pointed out that the conceptualization and management of social and environmental issues has evolved from a standalone concept to the notion of social responsibility and finally to the concept of sustainability. Social sustainability considers stakeholders such as employees (working conditions, level of remuneration, discrimination), suppliers, customers

(safety and psychological impacts of products), local communities (nuisances, respect for cultures) and society in general (Chardine-Baumann & Botta-Genoulaz, 2014). They have highlighted labor conditions, child and forced labor, freedom of association, discrimination, and so on. The initiation of a social compliance program like such as amfori's Business Social Compliance Initiative (BSCI), Worldwide Responsible Accredited Production (WRAP) and similar programs devoted to the improvement of social compliance in supply chain, where those issues were integrated through a practical approach (e.g. a supplier audit). The principles of these initiatives are often based on the principles of the UNGC, derived from the Universal Declaration of Human Rights, the ILO Declaration on Fundamental Principles and Rights at Work, the Rio Declaration on Environment and Development, and the United Nations Convention Against Corruption. Fashion brands and retailers are increasingly involved with such schemes as a relatively facile way to ensure compliance in the supply chain. Social compliance initiatives have an impact on improving working conditions, although those conditions are mainly limited to apparel production. Environmental vulnerability is more related to textile production, as well as concerning the lifecycle of the product. While the improvement of working conditions and workers' rights is considered a component of CSR, environmental issues represent an early approach to sustainability.

Since being institutionalized, the concept of sustainability has increasingly been integrated into company strategy. Ho and Choi (2012) have found that firms are becoming responsible for the environmental and social problems caused by their suppliers, and they see this responsibility as an opportunity to contribute to social goals and sources of competitive advantage. As a result, sustainability issues are receiving increased attention among businesses, and initiatives are often closely associated with CSR (Ahi & Searcy, 2013). Corporate social responsibility acknowledges the importance of the social dimension of sustainability (Hutchins & Sutherland, 2008). Resta et al. (2017) have highlighted the significance of the inclusion of sustainability principles in the competitive strategy of the company for competitiveness and to emphasize the importance of stakeholders. The stakeholders' requirement on responsibility is acknowledged as one of the most significant driving forces of responsible practices in a business. Depending on business type, the importance of the stakeholders may differ, but they have a role to play in driving sustainability practices. Seuring and Gold (2013) have argued that stakeholder pressures and respective reputational and legal risks are usually seen as key drivers toward the implementation of standards and codes of conducts.

Company reputation is perceived as one of the most important intangible drivers for corporations to be responsible and to achieve competitive advantage to improve their image. It is widely argued that most firms have adopted sustainable practices to strengthen brand names or differentiate their products (Ho & Choi, 2012). The various functions of SCO require synthesis of sustainability elements with other operational elements. For instance, according to Handfield et al. (2002), sourcing practices evolve from typical purchasing functions due to globalization, where purchasing has impact on corporate performance along environmental dimensions considering the waste and pollution generated. Environmental compliance programs assist manufacturers to make process safer and better, which provides better confidence in suppliers' environmental integrity among buyers, especially in who has limited visibility into the deeper part of the supply chain. As a result, environmental standards such as ISO 14000 or safer textile-production initiatives like bluesign, among many others, are becoming popular among companies, especially those that handle chemically intensive processes. Resta et al. (2017) have argued that the fashion industry is one of the sectors that has received the most public attention, and one of the most challenged by the sustainability concerns that have emerged in the media, including Detox by Greenpeace, the Sustainable Apparel Coalition, the Clean Clothes Campaign, the Roadmap to Zero Discharge of Hazardous Chemicals and the Fashion Revolution, to mention a few. However, these initiatives are often limited to the supply chains, and while some are familiar to business-to-business customers, they rarely known to consumers.

Ecolabels are commonly recognized as proof of the chemical safety of a final product and are often recognized by consumers. Numerous ecolabels have aimed to help consumers to identify products and services that have comparatively low environmental impacts through their life cycles (Clancy, Fröling & Peters, 2015), such as Oeko-Tex 100. the Global Organic Textile Standard (GOTS), the EU Ecolabel, and others. Brands also commonly provide supplementary information about product safety because of the growth of consumer consciousness. The rising acceptance of ecolabels by the consumer also presents proof of increases in consumer consciousness regarding the safety and sourcing of the products. Consumer awareness is significant in reducing the impact of a product's life-cycle, as Steinberger, Friot, Jolliet and Erkman (2009) have found in their analysis of a cotton shirt's 100 days of use: 73.5% of the energy is consumed during the consumer use phase (washing and drying 50 times), while 23.5% energy is used in production and 3% in logistics. Although the intensity of the impact depends on material and product type, generally the user phase produces a significant impact.

For the latter part of the life-cycle, consumers play a critical role, as consumer use and post-use require their direct contribution. Clancy et al. (2015) have highlighted downstream value-chain issues regarding use, reuse, recycling and disposal, arguing that those elements have not received the same level of attention, but a large potential for improvement can be found in post-sale life-cycle stages. Nevertheless, consumers are increasingly becoming aware of product sourcing, green features and proper disposal after use, and millennials are probably the generational forerunners in this respect. In their research, Niinimäki and Hassi (2011) have found that younger consumers are more worried about environmental and ethical concerns in clothing.

The enforcement of regulations at market level in recent days and the publicly available information about product recall (e.g. the EU's RAPEX [Rapid Exchange of Information System]) have raised the consciousness of consumers. Companies are compelled to build a CSR strategy and to take initiative, as cases like children's-toy recall or child-labor have evidenced among renowned companies (Gimenez & Tachizawa, 2012). Policy makers are influenced by various initiatives in the industry and by concerns from stakeholders, resulting in new regulations. Hasanbeigi and Price (2015) have found that the incremental trend of environmentally friendly textile processing drives restrictions on chemical use by governmental regulations. The recent inclusion of perfluorooctanoic acid (PFOA) and similar substances under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) program from the EU is one example of such inclusion in regulation, as per fluorinated chemicals (PFCs) are voluntarily banned by responsible brands already. In addition, certain global initiatives have been done on protecting the environment and climate on voluntary basis for businesses. Rajeev, Pati, Padhi and Govindan (2017) have evaluated the research triggered by awareness of sustainability in different periods, pre- and post-Kyoto protocol as well as pre- and post-Copenhagen Climate Council in 2011. held to agree on a new climate treaty to replace the 1997 Kyoto protocol. Their study shows a trend of increasing interest on various issues regarding sustainability, especially after the Kyoto protocol entered into force on 16 February 2005. The real rise in interest was observed after the 2011 summit, and few major industrial catastrophes occurred at almost the same time. The awareness and activities of businesses are shared through sustainability reporting, which has become common. Often, the Global Reporting Initiative (GRI) standard is followed, by which certain disclosures are mandatory. The guidelines bring many different topics into focus and were established as a global common language for transparency. Companies are also employing different

procedures such as emissions reduction, efficiency planning with respect to carbon footprint, or even carbon offset or compensation, acknowledging the importance of environmental responsibility.

3.1.3 Challenges in the fashion supply chain

A common problem for companies is to expedite the time taken to source materials, convert them into products and move them into the market place, which is invariably longer than the time the customer is prepared to wait (Christopher et al., 2004). It is evident that the challenges in the FSC are multidimensional and extended to the outside of the sphere. These changes can be widely categorized into challenges in manufacturing, a consumer-use phase, and a post-consumer phase. Although this study has focused mainly on challenges in the supply chain, this section also highlights other challenges, as they impact issues examined in latter stages of this research. The activities in the manufacturing stage are the proximate cause of many issues in the supply chain, and the propagation of those issues eventuated due to the globalization of the industry. Moore et al. (2018) list certain risks in outsourcing, where emphasis has been on social sustainability in the form of human rights violation, negative environmental impacts, and uncertainties faced by companies, including inflation, supply-chain disruption and increasing current risk of offshore manufacturing.

The long supply chain and decentralized manufacturing operations have produced a lapse in control of the quality of the products by the product owners (e.g. brands or retailers). According to Niinimäki and Hassi (2011), the movement of textile manufacturing towards lower-cost countries has affected the quality of garments to decline, which has shortened their lifetimes. More specifically, this shift in location has increased the risk of manufacturing-quality flaws and non-compliant products. Product compliance is critical, as failures and scandals seriously damage a brand's reputation (Tse, Tan, Chung & Lim, 2011). They have found that the severity and complexity of product-quality problems have been heightened by the magnitude of global sourcing issue. Consumers are also becoming more conscious of what they wear, and quality of clothing has become a paramount requirement (Kariuki, Wu, Gao & Ding, 2014). Furthermore, brands and retailers often provide product-safety standards and a Restricted-Substances List (RSL) to forbid use in production. Voluntary brand requirements and increasing regulatory requirements in various markets have ultimately put the manufacturers in a complex situation, increasing the complexity of supply chains.

Apparently, the industry shift occurred due to the need for cost savings, a need that has been further escalated by the evolution of FF. It resulted in pressure on margins, on volumes and on speed of service, which compressed the time in which a product can be in a supply chain (Popp et al., 2001). Fast fashion retailers incentivize customers to purchase more frequently, achieved through a low-cost supply chains and shorter lead times with high responsivity (Turker & Altunta, 2014). Price pressure is persistent, and the trend of a shift of the supply base towards low-cost areas is highly evident. Cost, profitability and ease of production via existing methods not developed with sustainability in mind pose challenges for sustainability (DeLong et al., 2013). Hallstedt, Thompson and Lindahl (2013) have found that social sustainability considerations focusing on working conditions including physical safety, low noise and very low proximity to toxic substances are among the common challenges in properly making products. Yadlapalli et al. (2019) have highlighted that the immense pressure to work under complex conditions and a lack of governance have recently resulted several fatal accidents: for example, a building collapse and fires in Bangladesh and Pakistan, unethical practices including use of child labor among Chinese apparel-manufacturers, the mass fainting of workers in Cambodian apparel factories, or violations of human rights in Vietnamese apparel factories. Such scenarios are endemic across apparel-manufacturing facilities in many developing countries. Some of these calamities have produced awareness among brands because of certain initiatives that resulted in their aftermath: for instance, the Accord on Fire and Building Safety (ACCORD) in Bangladesh. Pressure from NGOs has also escalated efforts, although poor working conditions and human rights abuses remain widespread.

While the apparel sector is burdened with various social issues, the extended part of the chain is a source of comprehensive environmental problems. As Gam, Cao, Farr and Heine (2009) have reported, the apparel industry is a major contributor to environmental problems from textile-material manufacturing to landfills replete with synthetic fabrics. The production of cotton causes major environment damage, since a large quantity of pesticides, fertilizers, and defoliants have been used in cotton fields. According to the GOTS (2018), 16% of the world's insecticides, and 10% of total pesticides, are used in cotton production, and 77 million agricultural workers suffer poisoning from pesticides each year. The extensive use of various kinds of chemicals in the textile industry have created direct impacts on human health, water resources and air, and many of the long-term impacts are deeply entrenched. In India and China, workplace safety is much lower than in Europe or USA, so worker exposure to dangerous chemicals and emissions

is much higher (Steinberger et al., 2009). Textile manufacturing consumes a large quantity of water and generates harmful waste from the chemically intensive processes (Gam et al., 2009). The stringent environmental and social laws in developed countries also result from adverse impacts on the environment, which cause of the polluting segments of the textile production (Rajeev et al., 2017). Furthermore, the lack of visibility for lower-tier suppliers complicates the task of lead firm trying to manage their supply chains sustainably, as they have less information and less influence. Those firms are typically SMEs and are less susceptible to environmental pressure from society, as they are not well-known (Tachizawa & Wong, 2014).

The growing trend towards sustainability and consciousness among stakeholders on social and environmental issues creating the pressure on organizations to ensure better practice in the supply chain. As Bossle, de Barcellos, Vieira and Sauvee (2016) have stated, the pressure exerted by internal or external stakeholders will be fed by the current scenario of sustainable development. Furthermore, global brands will continue to face increasing expectations from stakeholders as their operating environment changes and stakeholders become more educated on the critical issues facing the industry (Ansett, 2007). He insisted that the future issues emerging for apparel companies include the need to provide deeper assurance into the supply chain, full supply-chain disclosure and the adoption of a common COC, like the Joint Initiative on Corporate Responsibility and Workers' Rights code.

A highly demand-driven market obliges retailers to make very late change in design which are not the planned postponement. As Tyler et al. (2006) found, late-stage product changes occur frequently as the product nears the sales season, and these changes are costly and disruptive, often constrained by past decisions. The late changes often lead to flaws in production. Generally, fashion-sensitive products pose more risks than do basic products, and a highly fashionable product poses the possibility of commercial success and of obsolescence, which ultimately produces waste. According to Niinimäki and Hassi (2011), the clothing industry is based on extremely fast cycles of fashion and on consumers' unsustainable desires; hence, this industry is a good example of planned obsolescence existing in the current industrial system. Accordingly, low quality, short-term use, frequent clothing replacement and increasing textile waste create environmental problems. Furthermore, lowering manufacturing costs allows retailers to offer products at lower retail prices, which causes inflation and forces other retailers to sell more just to make same amount of money (Shelton & Wachter, 2005). An increase of

unsustainable consumption is one of the immediate impacts under such circumstances.

3.1.4 Supply chain key performance factors in the fashion supply chain

Various metrics are used to measure supply-chain performance, some of which are industry specific, relating to the nature of an organization or business (Elrod, Murray & Bande, 2013). Similar metrics are also utilized for prioritizing the areas of importance among the metrics. The FSC has different priorities due to the nature of the industry and the recent changes in it (e.g. a shifts of manufacturing location, the growth of FF, a focus on sustainability,). Sustainability is one of the performance criteria in the FSC aside from the typical supply-chain criteria. This chapter focuses on the key factors, from the FSC's point of view, used in this study.

Generally, for effective management in a supply chain, companies set measurement goals with the metrics that should represent a balanced approach and should be classified at strategic, tactical and operational levels, including financial and nonfinancial measures (Gunasekaran et al., 2001). Commonly, typical performance measurements often do not consider sustainability as a criterion or consider it as merely another parameter; however, sustainability cannot be limited to a single criterion. Certain studies have highlighted sustainability performance measurements (e.g. environmental performance, social responsibility and economic contribution) (Chardine-Baumann & Botta-Genoulaz, 2014), but the criteria in an evaluation merely consider sustainability issues such as the reduction of pollution, respect for human rights, and so on. In this study, factors are selected diligently based on the topics presented as sub-factors in the literature review. The different factors (see Figure 6) used in assigning the priority of sustainability among other factors are discussed below.

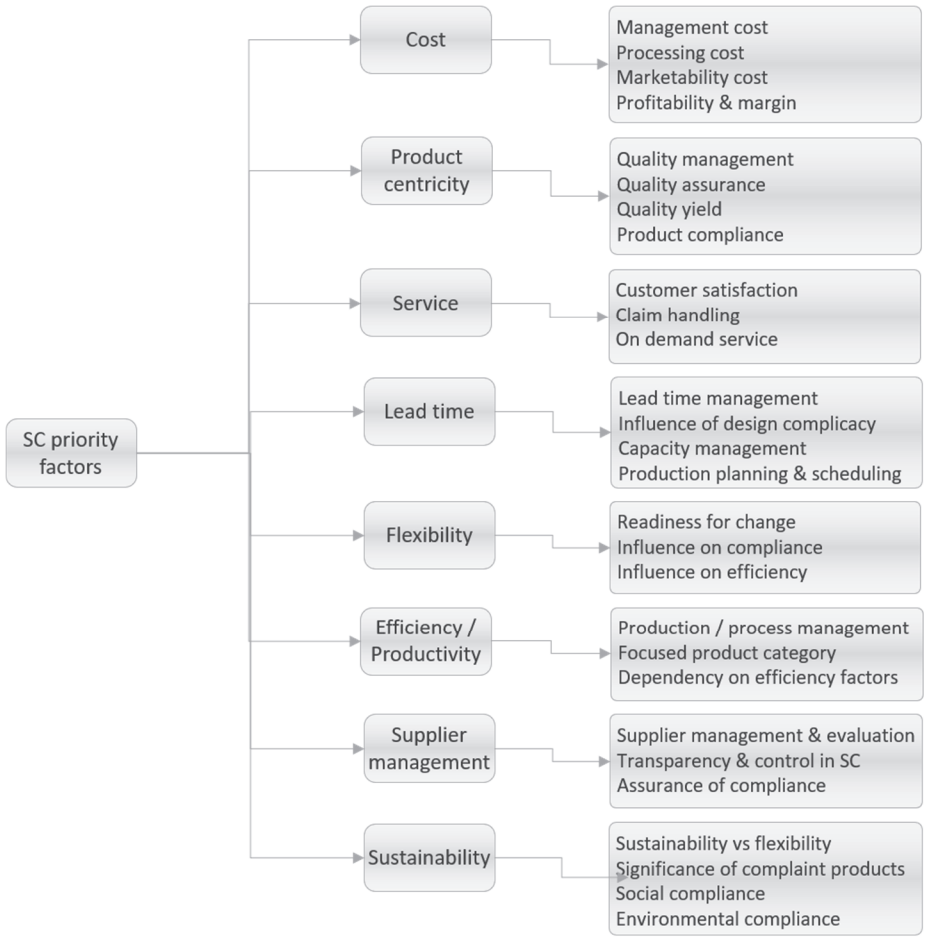

Fig. 6. Priority factors evaluation hierarchy.

Cost

Turker and Altuntas (2014) have highlighted that the fashion industry has a highly competitive structure to offer the newest possible trends to attract consumers frequently to buy at competitive prices. Elrod et al. (2013) have reported that competition has forced companies to consider new and innovative ideas to lower the costs of production without departing from the requirements of customers. They have listed different types of costs, such as financing (Carter & Rogers, 2008; Shepherd & Günter, 2006), distribution (Gunasekaran et al., 2001), information

processing, inventory and inventory obsolesce (Beamon, 1999; Gunasekaran et al., 2001; Mehrjoo & Pasek, 2016; Vaidya & Hudnurkar, 2013; Shepherd & Günter, 2006), manufacturing (Gunasekaran et al., 2001; Mehrjoo & Pasek, 2016;), finished goods inventory and warehousing (Shepherd & Günter, 2006), logistics (Vaidya & Hudnurkar, 2013; Mehrjoo & Pasek, 2016;), return on investment, and so on. Bossle et al. (2016) have found cost savings to be the most efficient way, as well as a motivation for an environmental management system. According to Vaidya and Hudnurkar (2013), traditionally, supply chains have been evaluated based on their operational costs, but this is not enough for the evaluation of the supply chain today. Cost effectiveness in operations is a necessity for companies to achieve economic sustainability, although DeLong et al. (2013) have perceived costs as one of the hurdles for sustainable practices.

Product centricity

Product quality is one of the most important customer requirements expected to be met even if other factors are not encouraging: for instance, low costs, short lead time or a more varied product mix. As an evaluation criterion for supply-chain performance, quality (Beamon, 1999; Carter & Rogers, 2008; Chardine-Baumann & Botta-Genoulaz, 2014; Turker & Altuntas, 2014) is often considered. Although quality as a performance criterion consists of many different types of quality performances, including operational performance issues; product-quality-related considerations are often a top concern, as is observed in the research (e.g. Gunasekaran et al.'s (2001) consideration of the quality of delivered goods). From a customer's point of view, delivering the required quality is a top requirement and is regarded as a reliability factor; from a supplier's point of view, quality is seen as an element of customer satisfaction (Sellitto, Pereira, Borchardt, da Silva & Viegas, 2015). Analyzing quality, they have listed subclasses such as percentages of scrap and rework, accepted orders, client satisfaction, return, remanufactured products and recycled amounts. The fulfilment of expected product quality in manufacturing is also a prime focus of the manufacturers. According to Romano and Vinelli (2001), the quality level delivered to the final customer is the result of the quality-management practices of each link in the supply chain, and this connection is relevant in the textile apparel industry. These scholars further emphasize the importance of quality assurance across a supply chain, as the final product's quality is the result of a chain of successive, inter-linked phases (e.g. spinning, weaving, apparel and distribution). In order to produce a compliant product and reduce risk,

different control points are essential in different stages and sub-stages. Assurance is done through activities such as quality inspections, which can be taken place before (i.e. third-party inspector) and after (i.e. in-house incoming inspection) materials are received, as well as after the product is completed (i.e. quality assurance by a third-party inspector) (Tse et al., 2011). According to them, insufficient quality assurance could lead to unsafe or defective products, usually not revealed until after the product reaches its customers.

Service

Shepherd and Günter (2006) have stated that measures of time and quality reflect the ability of a supply chain to deliver a high level of customer service. Service embraces almost all other criteria, as requirements differ by party, and service is perceived differently by each. A price-sensitive customer perceives a good price as a service, whereas quality could be a top priority for a high-performance product retailer. Gunasekaran et al. (2001) considers flexibility as a measure of customer service and satisfaction, in addition to other metrics such as a customer query link, service level compared to competitors, or customers' perceptions of service. Good service depends on many different parameters and measures. For example, according to Beamon (1999), customer responsiveness measures include lead time, stockout probability, and fill rate.

Lead time

The fashion industry is heavily season dependent, and a retailer's success depends on timely placement of the merchandise in the market. Furthermore, climate change has aggravated the uncertainty, as the climate is now more unpredictable than ever before. Although much effort has been expended in improving forecasting performance, yet it depends mainly on the tacit knowledge of buyers (Tyler et al., 2006). As the forecasting is even more challenging, people in sales try to postpone the product mix and order placement. In such circumstances, lead-time reduction (Mehrjoo & Pasek, 2016; Carter & Rogers, 2008; Turker & Altuntas, 2014) is critical, often providing a company with a competitive edge. According to Gunasekaran et al. (2001), reduction in the order-cycle time leads to a reduction in the supply-chain response time. Order lead time refers to the time that elapses between the receipt of the customer's order and the delivery of the goods. Small customized orders have longer lead times than large orders (Elrod et al., 2013).

They have suggested reducing idle time through better lead-time management. Vaidya and Hudnurkar (2013) have stated that controlling and compressing time shall increase quality, reduce costs, enhance responsiveness to customer demands and improve overall productivity. They have also highlighted the need for capacity utilization. Mehrjoo and Pasek (2016) report that the increase in the lead time at the upstream level leads to an increase in the retailer's inventory, so proper planning in production can balance demand.

Flexibility

According to Vaidya and Hudnurkar (2013), "flexibility" is defined as a network's ability to adapt according to particular need. Being flexible in the supply chain (Mehrjoo & Pasek, 2016; Chardine-Baumann & Botta-Genoulaz, 2014. Turker & Altuntas, 2014. Gunasekaran et al., 2001; Shepherd & Günter, 2006) refers to making available the products or services to meet the individual demands of customers (Gunasekaran et al., 2001). The dimension of flexibility can differ depending on the supply-chain setup. For example, while just-in-time supply encourages low inventory levels, these low levels may in turn conflict with the strategic goal of increased supply-chain flexibility (Shepherd & Günter, 2006). They have listed few flexibility criteria (e.g. order flexibility, new product development and mix flexibility) (Vaidya & Hudnurkar, 2013), production capacity and volume flexibility (Vaidya & Hudnurkar, 2013), delivery and transportation flexibility, customer needs, and so on. Flexibility as a measure potential must be applied to other production objectives, such as volume or delivery (Beamon, 1999).

Efficiency and productivity

Assurance of quality in production has a direct relationship with product cost and productivity. As Tse et al. (2011) have stated, the vast demand from Western firms for short lead time, creates challenges for producers to maintain their productivity. This situation is commonplace for producers upstream in the FSC, and competitive suppliers have engineered their setup to get an edge through a different approach. Bossle et al. (2016) have proposed that through cost reduction, equipment updates and R&D investments, efficiency related to manufacturing could be improved. Successful organizations have often implemented methods such as "lean" in order to reduce waste and improve productivity. Other factors such as the productivity of human resources, a comparison of actual versus planned throughput time to

determine process efficiency and inventory levels (Gunasekaran et al., 2001) are also noticed often as improvement measures. According to Shepherd and Günter (2006) effectiveness is the extent to which a customer's requirements are met, and efficiency gauges how economically a firm's resources are utilized when providing a pre-specified level of customer satisfaction.

Supplier management

The global shift of production of operations has increased dependence on suppliers. As production is often not in a company's own control, it is important to have trustworthy partners to achieve transparency. These partners are important not only for the assurance of ethical practice, but for operational success too. Tse et al. (2011) have stated that high supply-chain visibility reduces information asymmetry between the parties, which reduces the perceptions of risk in suppliers' and sub-contractors' product quality, as well as reduces the product- and performance-related errors, which in turn results fewer defects. Vaidya and Hudnurkar (2013) have listed certain supplier competences required to contribute to an effective and collaborative supply chain (e.g. technical and technological knowledge, tools and equipment, conformance to standards, safety practice, financial stability, product development capability, supplier agility and lead time, quality performance, and responsiveness). For example, to bring new product to the market, retailers have to depend on reliable and agile partners (Gunasekaran et al., 2001). The dependency on suppliers is also important to reduce risks related to product non-conformance. Bossle et al. (2016) write that noncompliance with regulations can be very costly to a firm (at the local, regional and international level).

Sustainability

Different sustainability performance measurements (e.g. social, environmental and economic) are common as standalone-performance measurements. Chardine-Baumann and Botta-Genoulaz (2014) define "sustainable performance" as a combination of economic, social and environmental performances. Turker and Altuntas (2014) observe that the procurement of raw or semi-finished materials from developing countries to achieve low costs could be a primary challenge in manufacturing because of the social and environmental conditions of their suppliers. Carter and Rogers (2008) see sustainability as means to reduce costs through sustainable actions and to avoid costly legal actions for poor environmental and

social performance. They have also stated that implementation of ISO 14000 standards for environmental management systems reduces costs, shortens lead time and ensures better-quality products. Beske-Janssen, Johnson and Schaltegger (2015) note sustainability management as a means to reduce risk by creating transparency about the social and environmental impacts of a supply chain. According to them, a third-party organization specialized on the measurement of the sustainability performance of suppliers (e.g. the BSCI for the textile industry, the Sustainable Apparel Coalition for apparel, etc.) should collect data from suppliers, develop databases accessible for all financing members of an organization, conduct supplier audits and organize supplier training.

3.2 Management methods in value chain

Businesses must collaborate to produce and deliver the merchandise to fulfil customer needs in the process of value creation. In present business environment, it is not enough to attain operational excellence in internal operations; rather, success comes through collaboration among partners in the entire value chain. Therefore, successful manufacturing companies adopt operational management to their supply chain. Management methods in a value chain have evolved greatly, according to contemporary need. Such methods are also quite evident in the FSC, which is also exemplary in mastering certain successful practices. Fast fashion, in particular, has set certain examples of SCM through a revolutionary method. This section highlights management procedures in general and in the context of textile-apparel chain.

3.2.1 Managing the supply side

The greater need to integrate various activities to meet contemporary demand for efficient flow of products and services originated from the widely accepted concept of the management of the supply chain. This concept encompasses various activities in the product- or service-creation process in order to provide improved customer value and achieve a competitive advantage. In principle, it connects different entities in the value-creation process for the greater benefit of the entire chain. Supply chain management has developed into a major conceptual approach inside management and business administration (Seuring, 2008). The concept of SCM extends the view of operations from a single business unit or a company to the whole supply chain. As Heikkilä (2002) has stated, a set of practices aimed at

managing and coordinating the supply chain from raw-material suppliers to the ultimate customer to improve the entire process, rather than focusing on local optimization of business units. Seuring (2004) has highlighted the physical flow and transformation of goods through all activities associated with the supply chain, as well as the associated information flow both up and down the supply chain. The integration of these activities is achieved through improved supply-chain relationships.

The need for the coordination of different units is critical in addressing many operational issues that are exposed in the case of a failure. Outwardly, it might be seen a demerit of the focal firm, but often it could be a result of multiple parties being involved in the process. According to Hilletofth (2011), supply-chain masters focus on coordinating and managing supply processes, to obtain a competitive advantage by providing comparable customer value at a lower cost. In a traditional purchasing function, price reduction is achieved through pushing down the purchase price or finding cheaper alternatives for materials. In the short-term the buyer–supplier relationship, the effectiveness in operations and a competitive price dependent on purchasing capability. Such purchasing may be effective in short-term success but cannot be regarded as sustainable practice. To improve partnerships among the members for everyone's mutual benefit, SCM streamlines all functions towards a unified goal. The concept of SCM evolved in this context as according to Jüttner, Christopher and Baker (2007), this is a strategic priority in many companies and has grown in importance since early 1990s in order to manage upstream and downstream relationships with suppliers and customers to provide customer value. Customers and suppliers are in greater isolation than ever due to the extension of the supply chain as an impact of manufacturing shifts. Cao, Zhang, To and Ng (2008) have found that the coordination in a supply chain is vitally important to determine the entire chain's performance, as the objectives and interests of each of the members in the supply-chain vary and conflict. Therefore, the importance of cooperation among partners has been found to be a success factor that mitigates discrepancies and flaws in operations and helps companies to meet product requirements. Such requirements were not greatly exposed during the era of local manufacturing, where non-tangible dissimilation in practices among companies was insignificant. Generally, supply and logistics network were not earlier extensive and manageable earlier. After the propagation of the supply and manufacturing network, companies realize the need for competences in managing external networks. According to Esper, Ellinger, Stank, Flint and Moon (2010), the relevant supply-side knowledge consists of insights into suppliers' products and

services, including their capabilities, past performance, and strategic initiatives. Furthermore, they emphasize information about technology, industry trends, networks, capacity, inventory levels, transportation, storage options, and the like.

The aim of SCM is to improve operational performance and, hence, to serve customers with greater satisfaction. Several studies have highlighted the need for performance evaluation and criteria for evaluation, as well as suggested the performance-improvement possibilities. Heikkilä (2002) has found that better performance can be achieved by consolidating customer and supplier bases, removing unnecessary steps, speeding up information and material flows, and creating long-term partnerships with major customers and suppliers to leverage the capabilities of several companies in a chain. While he has presented strategic issues related to performance, Hwarng and Xie (2008) have examined operational performances in their study, highlighting demand pattern, ordering policy, lead time, and information sharing as components with direct impacts on supply-chain performance and lead-time reduction. Lead-time reduction has further influence on the reduction of inventory and demand variability and on improvement of customer service and responsiveness. Gunasekaran et al. (2001) have emphasized the need for performance measurement, noticing the absence lack of a balanced approach and highlighting certain metrics (e.g. performance evaluation for planned order procedures, supply-chain partnerships, production-level measures, evaluation of delivery links, customer service and satisfaction, supply-chain finance and logistics costs). In a competitive business environment, even slight improvement can give an organization a competitive advantage, and performance measurement is a great means of achieving supply-chain success.

The SCM has a great significance on managing demand and supply due to the involvement of many parties and the complex structure of the supply chain. Cao et al. (2008) have observed that the textile-apparel supply chain is relatively complex because it encompasses several chucks of manufacturing processes, such as fiber and yarn processing, fabric manufacturing and finishing, garment manufacturing and retailing, and many intermediate processing steps. It includes also auxiliary-materials production and many different services. As retailers often depend on the manufacturing partners, they need to integrate and oversee such activities. It is particularly necessary to maintain lead time in each manufacturing stage, assurance of quality and greater transparency. Companies with better control of suppliers and the supply chain can build networks that reduce lead time. Jacobs (2006) has noted that most fashion firms rely on their partners for an important part of their value system to shorten the supply chain because of the long lead time in the FSC.

Furthermore, retailers are typically in an advantageous position in terms of exercising power because of their buying position. Tyler et al. (2006) found that buyer-driven commodity chains are characterized by tiered production networks involving countries offering a combination of low labor costs, relevant skills and production capacity. Generally, such countries can provide high-quality merchandise at low costs. Suppliers in different tiers in manufacturing are inter-connected in the network, which is critical to get materials cost-effectively and efficiently. MacCarthy and Jayarathne (2013) have found that the manufacturer, hence the direct supplier for the retailers, has the strong integration with fabric suppliers through ownership, strategic alliance or joint, ventures whereas retailers keep their ties with suppliers through their sourcing office or agents. They have found that fabrics and accessories are mostly supplied by suppliers who operate within the prime manufacturer's network, reflecting its upstream integration. However, a retailer commonly nominates the material suppliers if, even they do not have commercials tie with them.

3.2.2 Managing the demand side

The concept of DCM evolved from demand-driven management in the value chain, where the approach changed from manufacturing domination to a focus on market needs. This concept is aligned with growing needs for agility and quick responsivity in order to fulfil the market needs. The level of uncertainty in the fashion business has increased substantially in the recent past, which has stimulated the need for demand-based thinking. It has created further domination of the brands or retailers in manufacturing chains that traditionally look for stable demand. The rise of FF retailers and their dominance in the industry also changed practices towards a more demand-driven model. Therefore, quick response and lead-time reduction are key to fulfilling demand according to the concept of demand management. On the other hand, the challenge on the upstream side of the chain, namely to seize apt market demand due to the natural isolation from the market, has generated a need for a more demand-based approach. It is an endeavor towards reducing the gap in demand creation and fulfilment and bringing the dynamism into the whole supply chain process. Jüttner et al. (2007) have compiled the aspects of DCM that involve managing integration between demand and supply processes, managing the structure between the integrated processes and customer segments, and managing the working relationships between marketing and SCM.

Christopher and Ryals (2014) state that the idea of SCM emerged in a business environment assumed to be stable, and the focus was on network optimization and control. Furthermore, stress was placed on the availability of resources at affordable prices, encouraging organizations to make decisions over longer time horizons. Ideally, such criteria are fit for mass production, but obsolete in present circumstances, and therefore the industry discerned a need to modernize the supply-chain. According to Hilletofth (2011), demand chain masters focus on coordinating and managing demand to obtain a competitive advantage by providing superior value to their customers. Due to the advantage of proximity to the market and therefore to retailers and consumers, and given the possibility of utilizing the market knowledge, the demand side can produce a feasible prediction of future need and translate it through forecast planning for sourcing. Brands with direct access to consumers through retail or online are in the advantageous position of having up-to-date information and the ability to produce effective impacts on demand creation and fulfilment.

Jüttner et al. (2007) state that DCM captured the synergies between marketing and SCM to satisfy customers' needs, which is mandatory in today's marketplace. The customer benefits from real-time access to their account, making real-time changes in their customized product configuration and communicating their individual service requirements. These scholars have further differentiated that the SCM focuses on efficient supply and tends to be cost-orientated, but marketing is more concerned with revenue, focusing on the demand side of the company. To some extent, it is a reversal of manufacturing's tendency to utilize instruments in the supply chain from a demand point of view, which tends to put more emphasis on demand creation. Arguably, demand-side uncertainty extends to the manufacturing, which is not aligned with the spirit of the leanness, a method for which the industry has strived for long.

According to Jacobs (2006), the demand side is represented by the retailers who make decisions based on their knowledge and assessment of consumers' needs and desires. Accordingly, they prepare assortment and inventory planning in order to fulfil demand by bringing the right quantity at the right time with the help of purchasing. Although the DCM is a relatively new concept, the dominance of retailers is not new in the demand-supply context, especially in times of globalization. It is a predominant factor in the fashion industry, where the difference in relative power is remarkable, especially at the early stage. Cao et al. (2008) found that traditional brand owners in textile-apparel chain who are also distributors and retailers play the role of key coordinator in the value creation chain and have their

own design teams, specifying their own design requirements; furthermore, their manufacturing is conducted by their own nominated suppliers. Understandably, the need for the transformation towards DCM stemmed from needs from the downstream side of the supply chain. Before the impact of globalization, the FSC was rather short, and one could imagine that the gap between sales and production was not considerable, so that variance in demand was manageable. After the onset of globalization, the traditional isolation of demand and supply processes resulted in mismatches between demand (i.e., shortages of products that customers want or surpluses of products that are not wanted) and supply (i.e., what is actually available in the marketplace) (Esper et al., 2010).

In a typical FSC setup, the focal organization manages the intangible value-creation activities from the manufacturing perspective. Design and R&D are among the core activities aligned to organizations' strategic goals and the positioning of the company and brand in the market. Products are designed according to the theme of the brand in order to grow further in their own niche. The mission of retailing and marketing is aligned to the same idea, and product is the principal tool for them to flourish. They produce the demand and capture market trend to reflect the in design which is an important part of future prediction. According to Esper et al. (2010), in the demand-creation phase, knowledge is generated about future demand for the organization through the voice of customer information. This information can be collected through demand forecasting or statistical analysis. Successful organizations not only organize their supply chain to fulfil demand, but also learn market needs that can be realized through unique setup.

3.2.3 Demand-supply management

Previous sections have depicted SCM and DCM separately to highlight the concept of each management practice. This section concerns the synthesis both supply and demand, underlining the priorities of both sides. From the supply side, the term "supply chain" is used to describe the flow of goods from the very first process encountered in the production of a product right through to the final sale to the end consumer (Bruce & Daly, 2011). Traditionally, it has a supply-driven push approach, where efficiency and cost effectiveness are achieved through optimization mainly in production within a lean philosophy. Christopher and Ryals (2014) have stated that the SCM has tended to encourage a supply-focused viewpoint in which production push rather than demand pull is the dominant logic. They have argued that in the emerging DCM, new manufacturing techniques and enhanced

information flows enable supply chains to run, concurrently, with lower inventory and faster customer response. The traditional avenue to demand fulfilment has been shifting towards a consumer-driven approach to meet contemporary needs. Demand chain management is a concept evolved to make demand-driven practices in supply management more market focused and to extract the consumers' needs, where a focal firm is the link between upstream and downstream. Hilletofth (2011) found in his research that either the responsibilities of DCM or SCM should be extended to facilitate coordination between the demand and supply processes.

In the process of the evolution of management practices, DSCM is a concept that integrates both demand and supply side for operational improvement. Esper et al. (2010) have written about strategic integration of demand and supply in order to amalgamate the propositions from the demand- and supply-side operations, ultimately creating value in the market place. According to them, this integration is achieved through market information and business intelligence in the process of knowledge management. The need to address the priority of supply-driven SCM and demand-driven DCM triggered the need for DSCM. Hilletofth (2011) argued that the goal of DSCM is to gain a competitive advantage by providing superior customer value at lower costs, and the emphasis is both on increasing revenues, through the provision of desirable products and tailored supply-chain solutions, and on reducing costs, by managing the demand and supply processes in a cost-efficient manner. Demand-supply chain management concerns coordination of DCM and SCM across intra- and inter-organizational boundaries.

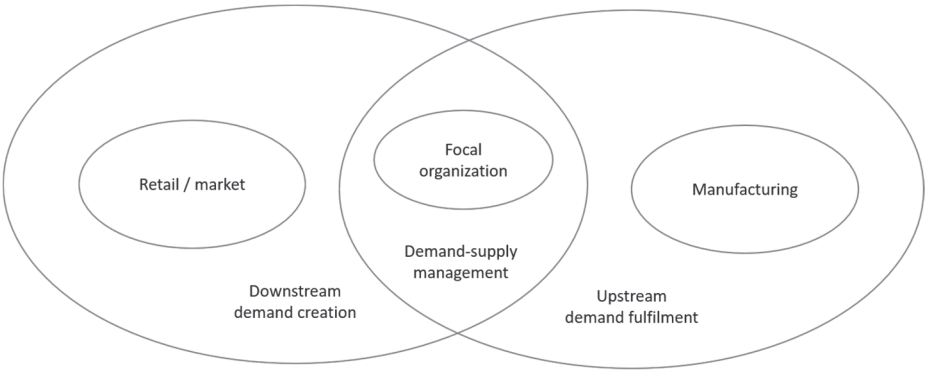

Fig. 7. Demand-supply synthesis.

Seuring (2004) provides some thoughts on the need to integrate customers' requirement from perspective of sustainability, because it might be seen as a

response to legislation or rising environmental pressure (e.g. close loop supply chains where goods are returned to manufacturers and also seen as an economic opportunities and managerial challenges). According to him, the textile industry is a good example of integrated chain management, as the industry is globally widespread, where different processing steps may occur in different countries. For the sake of the life-cycle approach, consideration of sustainability, transparency and organization is important in the value-creation process. Demand-supply chain management in the context of the textile-apparel industry is perceived as a feasible approach in terms of both demand creation and demand fulfilment. The focus in retailing and manufacturing differs, where the focal organization has a critical role in synthesizing priorities through DSM.

3.3 Sustainability in fashion industry

The fashion industry is often in the discussion for diverse issues in relation to sustainability. It is known for its high level of environmental impact, as well as its problems related to working conditions and workers' rights. Furthermore, the high level of uncertainty in the fashion business remains a concern for economic sustainability. There are significant changes also in consumer behavior, which are also linked to adverse environmental impacts. Consumers possess increasing amounts of short lifetime garments, which have been bought without deep consideration and used only a few times before being disposal (Niinimäki & Hassi (2011). The considerable reduction in the lifetime of products and the increase in consumption are two other growing concerns. This section presents the sustainability concerns related to the fashion industry that are relevant in this research.

3.3.1 Elements of sustainability

Sustainability has become a buzzword omnipresent in business and among stakeholders (Carter & Easton, 2011). It encompasses various issues within the scope of the TBL and is used in relation to many different considerations. Sustainable business practice should consider the elements of nature and society in business practice. In their literature review of sustainability in SCM, Ciccullo, Pero, Caridi, Gosling and Purvis (2018) distinguished certain environmental and social aspects in SCM: environmental supply-chain monitoring practice, environmental SCM systems, environmental new product and process development, social supply-

chain monitoring, social SCM systems, social new product and process development systems, and social supply-chain strategy.

The widely accepted definition of sustainable development in the Brundtland Report emphasizes social justice and human rights; in contrast, for decades of the environmental movement, the operational emphasis on sustainability has explicitly been on the environment (Ceschin & Gaziulusoy, 2016). In the fashion industry, the term is typically perceived in connection to environmental consciousness and activities devoted to reduce environmental load. According to Carter and Easton (2011), the terms "sustainability" and "environment" have been used interchangeably in scholarship and in industry, especially in the early conceptions of sustainability. Tseng, Lim and Wong (2015) have claimed that early sustainability initiatives have focused mainly on environmental issues, but over time, they have increasingly adopted environmental, economic, and social perspective-driven approaches. Although CSR practices usually focus on social betterment, the global shift of manufacturing towards less-developed countries has exposed many human-rights-related issues. Social aspects, as a component of sustainability, started to be addressed profoundly, due to this increasing need. Ikerd (2012) has stated that the relationships among nature, society and economy are hierarchical, where nature represents a higher organizational level or plane than does society, and society represents a higher level of organization than the economy.

According to Carter and Rogers (2008), organizational sustainability refers to an integration of TBL elements, and businesses considered those three bottom lines, as opposed to the purely environmental considerations urged in the early days of sustainability discourse. These scholars have listed activities that are sustainable: for instance, reduced packaging (which also saves costs), designing for disassembly, better working conditions with safer warehousing and transportation for better labor turnover, reduced health and safety costs, and productivity, an environmental management system (e.g. ISO 14000) for reduced costs, shorter lead times, and better product quality. This section presents typical sustainability considerations in light of these, and it highlights issues related to product sustainability separately, to impose the importance of studying it with greater priority.

Environmental considerations

The textile industry uses a large amount of electricity, fuel and water in different processing stages, and it produces a significant volume of contaminated effluent and air pollution (Hasanbeigi & Price, 2015). With the continuous increase in

consumption and reduction of resources, the importance of environmental sustainability is higher than ever before, and the fashion industry is a top polluter. Chemically intensive textile processes are the main source of water and air pollution in the industry, although according to Steinberger et al. (2009), carbon emissions could emerge more in the consumer phase, at least for certain material types. De Brito et al. (2008) have expressed concern for the environmental impact of the fashion supply chain, specifically the intense use of chemicals such as dyes and the high demands on land and water use (e.g. for cotton growth). The banning of harmful substances in textiles in different countries and the voluntary implementation of the RSL have reduced the use of harmful substances to some extent. Although these restrictions limit dangerous substances in the waste, even the so-called non-harmful substances used in processes increase water pollution if effluent is not properly treated. Furthermore, new innovations on textile performances have created new chemical formulations in manufacturing, resulting in more contamination. Aside from chemical waste, apparel retailing is responsible for producing different physical wastes, which also increase environmental load. According to Handfield et al. (2002), the products companies produce increase waste during storage, transportation, processing, use and disposal.

Ljungberg (2007) has stated that environmental problems have often been seen as local problems, but today it becomes much more complex and related to all phases in a product's life-cycle. Once-isolated problems have evolved into global problems, as is evident through climate change. Carter and Easton (2011) have depicted a wider picture of environmental impacts related to climate change, which is now a key issue of global concern. Ceschin and Gaziulusoy (2016) have highlighted research emphasizing action related to climate change due to the rapid decline of both terrestrial and aquatic ecosystems and declining biodiversity. Microplastic pollution is one of the most pressing environmental issues, deeply influencing on aquatic ecosystems and terrestrial habitats. Henry, Laitala and Klepp (2019) have researched the impact of plastic microfibers (< 5 mm) and nanofibers (< 100 nm) on the environment, and these fibers are produced in different stages of textile life-cycle (e.g. during production, use and end-of-life disposal). According to them, non-bio-degradable microplastics found in a marine environment, in soil and even in air, have several different types of environmental impacts (e.g. exposure to different environments causes multifaceted ecological and human health issues; physical impacts in organisms occur through ingestion; chemical impacts appear through leaching of plastic additives such as antioxidants, dyes, fire retardants and the like; biological impacts emerge from microplastics providing

new habitats for organisms and new sites for microbial colonization; impacts emerge for human health due to ingestion and inhalation).

Greenhouse gas emissions are another problematic area of the environmental impact of the fashion industry. The shift of production location and the widespread production network globally have complicated regional and international logistics significantly. In many cases, the production of yarn, materials production, material finishing and garment production are located in disparate places. Furthermore, the impact of FF and the quick replenishment need often compel suppliers to send goods by air freight. Turker and Altuntas (2014) have discuss the heavy environmental burden of increased transportation mileage and expediting shipment through air, which significantly increases carbon emissions. Chardine-Baumann and Botta-Genoulaz (2014) have emphasized sustainable transportation for efficient customer response. According to them, best practices are linked to sustainable development and five environmental indicators: carbon emissions, air pollutant emissions, liquid waste generated, solid waste generated and percentage of recycled waste.

Social considerations

Humans are interrelated to the whole of nature and instinctively seek recognition and pay attention to how others treat them (Ikerd, 2012). A greater share of social sustainability embraces concerns over human-rights- and worker-welfare-related issues that are common in the FSC. Turker and Altuntas (2014) have noticed that due to low skill requirements for workers' entry into the industry, women and young workers are being used cheaply, making the apparel industry vulnerable to discrimination, abusive treatment, low wages and long working hours. Islam and Deegan (2008) have highlighted those common issues, which are frequently raised related to employment of child labor, human rights abuses, poor working environment, inadequate health conditions in factories and a lack of safety measures, resulting in frequent accidents and deaths. Furthermore, concern over living wages (Yadlapalli et al., 2019) is rising in many manufacturing countries, due to increases in living costs. In their research on the Chinese clothing industry, Zhang et al. (2016) have found that wages in the clothing sector are lower than the national average and that the labor-intensive clothing manufacturing remains concentrated on cheap labor. Huq et al. (2014) have conducted research in the context of Bangladesh's Ready-Made Garment (RMG) sector and found social sustainability problems related to human rights (e.g. child labor and freedom of

association), health and safety (e.g. safe working conditions and training) and community (e.g. charitable, philanthropic initiatives). In their literature review, they list barriers including limited resources; low prices offered by buyers; lack of management and supplier commitment; and communication problems and cultural mismatch with suppliers in different locations.

The issues related to social compliance have long been of concern, and many initiatives are noticeable among the brands and retailers. Social compliance initiatives in the supply chain have been able to alleviate those problems to some extent, but there remain criticisms about the effectiveness of those systems. Lund-Thomsen and Lindgreen (2014) highlight vulnerability related to workers safety by mentioning some recent cases: for instance, the Ali garment factory fire in Pakistan in 2012. even soon after SA8000 certification and the Rana Plaza factory collapse in Bangladesh in 2013. There are many concerns related to social compliance, and prioritization is critical in order to improve the overall condition. When human life is in focus, no other issues can be prioritized, and comprehensive effort is required to improve safety in workplaces. The ACCORD is a legally binding agreement between retailers and trade unions to build safer apparel-manufacturing facilities in Bangladesh (Yadlapalli et al., 2019). As a major apparel exporter, and with fatal accidents in recent past, Bangladesh is in focus for workers' safety and compliance-related issues. Haque and Azmat (2015) have studied CSR-related topics in the RMG sector in Bangladesh, listing eight important topics, namely occupational health and safety, fair pay, legal considerations, social welfare and work-life balance, labor rights, environment, gender issues and fair trade. It is worth mentioning that the challenges differ somewhat in textile production and, beyond, in the supply chain. Particularly, in cultivation of cotton, for example, it is common to find that children are helping their parents. In some cases, even, income from underaged workers is a major means of survival for families. For example, in the context of the socio-economic conditions and differences between buyers and suppliers, a closer look reveals that many families in developing economies live in extreme poverty and therefore often depend on income from child labor (Busse et al., 2016).

Although there are laws regarding safety and rights in those countries, the enforcement of those laws is not common, for several reasons. Often, a lack of management and corruption hinder the implementation of the laws and of any effective initiatives. Therefore, compliance requirements and CSR practice in a supply chain is perceived as a most effective method to improve the situation. Perry and Towers (2013) have stated that fashion retailers employ international standards,

extended frameworks, supplier codes of conduct and supplier social audits for poor working conditions in supplier facilities in order to address social issues such as wages, working hours and working conditions. According to them, fashion retailers have been accused of chasing cheap labor around the globe, which is a barrier to sound social practices. In CSR practice, materiality analysis provides an important material aspect that often helps brands or retail companies to prioritize CSR-related issues. Although priorities may vary, the common issues have stated already in this section. Yadlapalli et al. (2019) have listed common priorities such as child labor, environmental management systems, formal evaluation, lack of health and safety standards, and human rights abuses, which are found to be the most critical for retailers. Retailers take necessary measures and audit their supply chain focusing on these critical issues, as authorities are often unable to take measures to restrict those problems. Beschorner and Müller (2007) have found that political regulations are less and less able to offer solutions for urgent social problems especially in developing countries and in countries with emerging markets.

Ikerd (2012) has argued that the social principles of trust, kindness, and courage are equally important in sustaining economic relationships. He adds that legal documents useful in dealing with untrustworthy relationships and contracts can be unfair if they are negotiated between parties with unequal bargaining power, as is often the case in this industry. Suppliers' COCs or requirements of social compliance certifications might bind suppliers to act ethically, but in order to achieve meaningful social welfare, a true buyer–supplier relationship is essential in which the combined effort focuses on human rights. The responsibility to the proximate society also remains part of social sustainability, as Walker and Jones (2012) mentioned, and the economic aspect of SSCM can include buying from local suppliers to support local economic regeneration.

Product sustainability

Generally, a product is recognized as sustainable when it is produced using sustainable raw materials with less impact on the environment. The demand for sustainability in a product is rising, and the consideration of sustainability in business is also on the rise, to fulfil the market demand. In order to sustain business in fast-changing global market, pursuing business sustainability goes further than just using natural materials or motives for fashion design (Na & Na, 2015). According to Chi (2015), environmentally friendly apparel should have one or more characteristics among the following: recycled materials, durability, apparel

organically grown fibers, low-impact or no-dye processing, or environmentally friendly labelling or packaging. There are different kinds of impacts on the environment produced through extraction, refinement, transportation, product use, recycling or deposition of materials (Ljungberg, 2007). According to her, a sustainable product produces fewer possible impacts throughout its lifecycle. This lessened of impact is only one aspect of product sustainability, and this research considers other aspects for sustainable products (e.g. quality, compliance and safety).

The organization of supply chains in the fashion industry is substantially product dominant. The degree of sustainability or the level of quality of a product guides processing requirement in the supply chain and the selection of the suppliers based on their capability to meet the requirements. Romano and Vinelli (2001) have stated that better quality can be achieved through better supplier management and that especially in the textile sector, quality can no longer be considered for high fashion or expensive clothing. They have mentioned the different physical properties of textile products in connection to durability, as well as emphasized that consumers are increasingly aware of environmental pollution and the use of eco-compatible chemical products has become one of the ways of evaluating the quality of a product. A sustainable product requires a manufacturing process to be safe and free from harmful substances. Product safety is not ultimately an isolated issue, and if a safe and eco-friendly procedure is not adopted throughout the manufacturing process, safety cannot be ensured. Eco-friendly processing and the environmental-sustainability imperative to produce compliant and sustainable products for product compliance cannot be ensured through product testing alone. On other hand, for the physical safety of products, quality assurance in different phases of manufacturing plays a critical role. Tse et al. (2011) have suggested quality assurance at the manufacturing stage and quality inspection of the final product for risk prevention. They also express concern about product safety due to the diffuse supply network and the poor visibility of various links in the supply chain, which increase quality risk in a global supply network, as is evident in recent rises in product recalls. In their review of the Consumer Product Safety Improvement Act (CPSIA), Leone and Berger et al. (2009) found that the extensive official recall procedure and penalty imposition leaves the companies with both regulatory challenges and liability dangers. Occurring more frequently now than in past, product recalls, which is the removal of products from commercial availability due to a safety hazard, occurs because of a quality fault due to defective products and product-safety issues (Ni, Flynn & Jacobs, 2014). They divide the significant cost burden

related to recall operations into direct costs, often in relation to manufacturing, and indirect costs, for administration and recall operations. In many cases, financial losses are not as significant compared to the damage that occurs due to reputation loss and lost sales. Companies are presently required circumstances to improve their risk-management practice in relation to product failures to achieve economic sustainability.

Haas-Kotzegger and Schlegelmilch (2013) highlighted product safety as a major social, political and economic concern and therefore companies are involving product safety in CSR initiatives to ensure that consumers are aware of their initiatives. Corporate social responsibility reputation also works as a shield against negative consumer response, as negative-information dissemination has a significant impact on sales. Clancy et al. (2015) have found that the textile and garment industries have worked to reduce their environmental impacts in the upstream value chain related to manufacturing; this reduction has occurred in the context of cleaner production and better social practices. Downstream value-chain issues regarding use, reuse, recycling and disposal have not received the same level of attention, though. It is commonly believed that the impact is produced on the manufacturing side, but a significant impact is also produced in the consumer phase. For example, for a T-shirt, over 70% of the energy use and CO_2 emissions occur in the consuming country, whereas for the jacket, more than 70% occur in the producing country (Steinberger et al., 2009). Therefore, the consumer plays an important role in reducing impacts, and it is important that consumers know the relevant information. Ljunberg (2007) has emphasized the importance of informing people as to the basis on which a certain product is considered sustainable. According to Clancy et al. (2015), ecolabels aim to help consumers to identify products and services that have comparatively low environmental impacts throughout their life-cycle. Another important aspect of communication is instruction on proper care for the product for least impact during use. Lengthening the product's life time and proper care can significantly contribute to the reduction of the impact. Maldini, Stappers, Gimeno-Martinez and Daanen (2019) have expressed concern about clothing's life time and obsolescence for the shorter life-cycle of clothing products, replacement and rising quantities of clothing production and consumption. The evolution of FF and throw-away culture has escalated the environmental burden by prompting the use of more natural resources because of the increase in consumption and the shortening of the lifetime of the products. These happenings not only use more resources, especially non-renewable, but also more resources in the consumer phase, producing much waste, some of which has

potential long-term effects (e.g. micro-plastic pollution). The shortening of the product lifecycle among low-quality products is often proportional to reduction in cost and increase in the obsolescence of fashion. Ceschin and Gaziulusoy (2016) have stated that for some product categories, the end of the lifespan is not caused by technical issues, as it has been estimated that 78% of discarded products continue to function properly when replaced; in some cases, this is due to psychological obsolescence. They have defined psychological obsolescence as occurring when a product is discarded for reasons such as changes in a users' perceived needs, desire for social status emulation, or new trends in fashion and style. It is important that the impacts in different stages of the product's life are studied in order to reduce these impacts. Life-cycle analysis offers an approach to integrate the environmental impacts of a product over the whole value chain; Dahlbo, Aalto, Eskelinen and Salmenperä (2017) has used this approach in studying the environmental impact of the current textile-reuse and textile-waste-recovery system. Their study has shown that both increased reuse and recycling can reduce environmental impacts beyond what is now common, if virgin textile production is compensated. Bevilacqua, Ciarapica and Giacchetta (2007) have found that LCA provides the framework for evaluating environmental load and is a useful technique for product development in the context of environmental sustainability. They have advocated for design for environment in relation to LCA, which considers potential environmental impact throughout the life-cycle of a product, including emissions of harmful substances and excessive use of energy or non-renewable energy sources.

Niinimäki (2006) has classified often-used terms among sustainability considerations in design: design for environment, which is the analysis of the environmental, health and safety issues relevant to the entire life of the product; eco-design, which is an environmental-impact-related design process; and sustainable product design, which is a philosophy and practice in which products contribute to social and economic well-being. Niinimäki and Hassi (2011) have argued that product design and manufacturing are oriented to meet regularly changing trends and quick profit rather than producing designs focused on consumer needs and sustainability. In general, eco-design products are limited to the use of sustainable materials, which has less impact on environment. Although these practices have stimulated concern, to make a meaningful impact, a comprehensive strategy is obligatory to consider the content of the products, how and where they are manufactured, what the possible impacts are during the consumer use phase and the fate of the products in the post-consumer phase.

Ceschin and Gaziulusoy (2016) have stated that the 'design for sustainability' has progressively expanded from a technical and product-centric focus towards a focus on large-scale system-level changes in which sustainability is understood as a socio-technical challenge. The design phase is critical from the life-cycle perspective as the bill of material (BOM) is finalized in this phase, setting the fate of the life-cycle of the product. Product development is no longer considered merely among the aesthetical features, but it also connects to technical aspects related to product properties and manufacturing for sustainable life-cycle by keeping it as competitive to achieve desired profitability.

3.3.2 Sustainable supply-chain operation

In the FSC, retailers as buyers of merchandise are situated in a developed economy and source their products from established apparel- or textile-producing countries typically situated in developing countries. Due to the long distance between the market and suppliers and various hurdles erected in the supply of raw materials and finished product, supply-chain complexity has increased significantly. Brun and Castelli (2008) have stated that competitiveness depends on managing a supply chain rather than on an organization itself, and sustainable advantage could be achieved through the management of interconnection between organizations in the network. Managing a supply chain sustainably is an area of increasing interest among academics and supply-chain professionals. Competence and operational performance as well as the sustainable performance of the focal firm for SSCO are critical for the success of the entire chain. In SSCO, sustainability elements are amalgamated into operational elements, which do not consider sustainability as a standalone issue. Svensson (2007) has stated that SSCM is a broadened approach of SCM that emphasizes economic, ecological and social aspects of business practices and theory. According to him, the aspects connected to sustainable business practices and theories are seen separately: for example, different supply chains dedicated to recycling or waste handle the same product. Although the post-consumer phase is a critical part of the total supply-chain organization, this research focuses on the pre-consumer phase. The eventuality of apparel product depends largely on how the post-consumer processing aspects are considered in the R&D and design phase. Textile recycling is an evolving area, and the product development should already consider the possible technologies available when the product's life ends. Aside from consideration of the end of the life-cycle, a sustainable supply chain should also focus on upstream manufacturing to ensure

the least possible impact. Svensson (2007) has reported that certain generic terms are introduced to address SSCM based upon the degree of renewable or non-renewable and recycled or non-recycled resources used.

A significant number of studies conducted for SSCM have focused on building the process and attempting to define by considering the TBL aspects in SCO. Some have focused on the features that distinguish the SSCM from a typical SCM by insisting on the importance of the topic. As Azevedo, Carvalho, Ferreira and Matias (2017) has stated, while the SCM increases organizational effectiveness and enhances competitiveness, customer service and profitability, it has also a crucial influence on the sustainability of a business. They have argued that the implementation of practices that promote the overall efficiency of the company and supply chain requires a deeper examination of TBL issues. According to Carter and Rogers (2008), SSCM is the strategic, transparent integration and achievement of an organization's social, environmental and economic goals in the systemic coordination of key interorganizational business processes for improvement of the long-term economic performance of the individual company and its supply chain. Walker and Jones (2012) have stated that SSCM means that organizations are held responsible for the environmental and social performance of their suppliers. A study on governance mechanisms by Formentini and Taticchi (2016) found that business sustainability is defined in reference to the TBL, which calls for a re-thinking of the way in which business is designed and conducted and classifies supply chains based on the governance mechanism into sustainability leaders, practitioners and traditionalists.

Tseng et al. (2015) have studied various SSCM concepts and found that it should consider all three aspects of sustainability to achieve long term economic viability in SCM, which is also a strategic factor for increasing a firm's effectiveness. It also includes the provisions of sustainable products achieved through the cooperation of interconnected business networks in order to ensure the sustainable movement and storage of raw materials and products up to point of consumption. Product-related sustainability considerations identify corresponding impacts on the environment, and companies consider these impacts for long-term business sustainability. Zhang, Tse, Doherty and Akhtar (2018) have stated that truly sustainable supply chains can produce long-term profitability without harming natural and social systems. They have produced a framework to evaluate eight synergistic management practices: namely, sustainable product design, environmental procurement, environmental customer collaboration, internal green management, investment recovery, diversity management, community

development, and involvement and safety management. The main aim of SSCM is to integrate sustainability into SCO, yet some studies have focused on sustainability only because of the exertion of the priority of environment in the SCO. Businesses prioritize environmental aspects in their SCO due to demands from stakeholders or of corporate responsibility, which also give them a competitive edge. Nagurney and Yu (2012) have claimed that consumers', and as a result retailers' or brands', demands are to produce and distribute products in a manner that minimizes the use of toxic chemicals, prevents pesticides in cotton cultivation and reduces the generation of waste in terms of textiles and by-products.

For sustainable operations of the supply chain, besides setting the strategy and planning, the companies' need to organize the supply chain, as the implementation requires comprehensive effort from the partners. As Azevedo et al. (2017) have stated, several companies in the supply chain (e.g. suppliers, manufactures and distributors) act together to improve the TBL performance. They have further added that several other organizations, including NGOs, governments and supervision entities, are key drivers of the implementation of SSCM practices. External pressures are one of the main driving forces to seriously consider sustainability in company strategy. Carter and Easton (2011) have found that there are several drivers for this rising prominence of sustainability, including supply and demand characteristics surrounding energy consumption, increased understanding of the science relating to climate change and greater transparency concerning both the environmental and the social actions of organizations. Therefore, supply-chain managers are in a particularly advantageous position to impact – positively or negatively – environmental and social performance through, for example, supplier selection and supplier development, location decisions, and so on. Special importance is placed on supplier selection and performance in different studies, and the focal company has the responsibility to ensure sustainable practices. According to Faisal (2010), outsourcing strategies make it more difficult to exercise control over working conditions in offshore production sites (particularly in developing economies); smaller size of deliveries deriving from shorter delivery times may increase the number of shipments, thus raising environmental impacts. In particular, sustainability practices are a daunting in supply chains where issues such as price competition and responsiveness are of prime importance. One of the most widely used methods is supplier auditing in order to ensure that the provided requirements and guidelines are followed properly. It is a common practice in the FSC that different customers of a supplier have different requirements. Therefore, independent audits are also common in the industry, where different retailers are

members of an organization, and a third-party audit is conducted (e.g. a BSCI audit). However, these programs focus only one aspect of sustainability, and they might not thoroughly align with a company's sustainability strategy. Carter and Rogers (2008) have found that the common auditing procedures adopted by an industry coalition can allow a single, effective supplier sustainability audit, increasing transparency and supplier sustainability performance while lowering transaction costs for both the supplier and the multiple buying organizations.

Walker and Jones (2012) found few enablers in their review of SSCM-contingent factors (e.g. commitment, engagement, capabilities and collaboration). Among the notable barriers are lags in structure and process, commitment, cost reduction, competitive pressure, greenwashing, regulation, and so on. The shift of production in the fashion industry has not considered sustainability, as prime considerations have primarily included cost reductions. Traditionally, supplier development has focused on economic goals and sought to develop suppliers' economic performance and capabilities related to quality, cost and delivery (Busse et al., 2016). In later stages of the manufacturing shift, the rapid manufacturing and need for fast delivery from the retailers have urged manufacturers to adapt agile practices, exerting additional stress upstream. The FSC has evolved by prioritizing those issues, and sustainability considerations have begun to be integrated based on incidents, labor rights or environmental issues, when required. Naturally, manufacturers are thus confronted by practical challenges when they are urged to take those issues into account. Faisal (2010) has highlighted that for sustainable practice, suppliers need to change their existing production practices by investing time and resources into acquiring new skills and into improving infrastructure. In practice, these are not readily available in developing countries, where investments from firms are required. Once investment is made, the operating costs or returns on investment are often a concern for the companies, as the market demands ceaselessly lower costs in manufacturing. Macchion et al. (2018) have noticed that approaching sustainability implies several difficulties for companies, which can limit their willingness to undertake social and green actions due to the high costs associated with sustainability projects and the long-horizon returns on investments in such projects. Although cost is one of the practical barriers, there are intangible capability requirements that make the work challenging. Lion et al. (2016) found in their study that even though the organizations were conscious of the importance of sustainability and the top management had an interest in it, they were unable to initiate the path to sustainability because of insufficient competences or resources. Again, the understanding of the importance of the issues may vary due to cultural

barriers, as the importance is perceived widely in the developed countries but not necessarily in manufacturing countries with developing economies. Busse et al. (2016) have identified that socio-economic differences between the operating contexts of buyers and suppliers have emerged from the date as another, somewhat perplexing and counterintuitive barrier.

3.3.3 Agility and sustainability

Agility is one of the most critical elements for the success of FF, and it is evident from the previous discussions that the FF business concept is not at least complementary to sustainability. This section highlights the essence of agility for FF and its impact on sustainability. The evolution of fashion culture and growth of FF has resulted a change in the practice of supply-chain organization. Consumers today are more fashion conscious and prone to follow trends. This change has been captured by fashion retailers and seized as an opportunity for the growth. This new trend in the industry has been dubbed FF, which Barnes and Lea-Greenwood (2010) define as a concept by which retailers organize their businesses to minimize the time to bring a product to a store and emphasize in-season buying. Tokatli (2008) has listed certain characteristics of FF, where the retailers tend to reach more customers around the globe, connect customers' demand with the upstream, short development cycles, very fast and highly responsive supply chains, and so on. Evidently, FF is demanding, and pressure exerted on the supply chain. Notably, agility is of ultimate importance and is a success criterion on both the demand side and the supply side.

Agility is a business-wide capability based on organizational excellence to achieve flexibility, and it originates from a flexible manufacturing system (Christopher, 2000). The nature of the textile business and products tends towards the adoption of agile practice. Mason-Jones, Naylor and Towill (2000) found that fashion products, especially trendy clothing, have short life-cycle and high demand uncertainty, with the risks of both stock-out and obsolescence, whereas supply chains require strategy to match supply and demand and to enable companies to respond more rapidly to the marketplace. During the early phase of the global shift of the industry, companies were indeed prone to adopting a lean methodology, especially in manufacturing, as the focus was predominantly on productivity and cost reductions. According to Christopher (2000), where demand is predictable and the requirement for variety is low and volume is high, it make sense to align the strategy with lean philosophy, although they note that leanness alone will not enable

an organization to rapidly meet the precise needs of customers. Even if a firm's operational strategy is based on agility, leanness as an element in agile practice is beneficial. Especially in manufacturing, the elements of lean principles are critical for disciplined production and reduction of cost, which is an absolute need in the FSC, where cost is the main driving factor. Mason-Jones et al. (2000) have stated that agility is the step after leanness and that firms should focus on both. Accordingly, enterprises should strive for agility even if it is not the ultimate objective and should focus on achieving the leanness.

Barnes and Lea-Greenwood (2010) have found that the reduction of lead time from concept to consumer and facilitation of in-season buying to fulfil the customer demand is the point of success. Although this phenomenon corresponds to FF, it is now characteristic of the industry in general, as the dominance of FF is prevalent. Bruce and Daly (2011) have stated that the textiles and apparel industry tends to be dominated at the end of the chain by large, powerful high-street retailers, and back down the chain, the manufacturing sector of the industry consists of large numbers of small companies with limited power. Suppliers are therefore accustomed to the need and have developed their capacity to stay competitive. Bruce and Daly (2011) argue that careful management of the supply chain is required to reduce lead times and to achieve quick response, so agility is appealing in this context.

Much has happened in terms of agility, although in recent days, concern is shifting towards sustainability. Dramatic changes in the fashion industry, coupled with environmental concerns giving rise to conscious consumers in terms of fair trade, the green market and organic clothing (Bhardwaj & Fairhurst, 2010). There is criticism in the industry for promoting unsustainable practice through planned obsolescence and throw-away culture. Niinimäki and Hassi (2011) have stated that in the recent past, improvement have been achieved in terms of environmental impacts in manufacturing, but due to an increase in production and consumption, the associated benefits cannot be realized. They further add that reduction of prices through improvement in production efficiency has made fashionable clothing widely available, which has resulted in an increase in consumption and a shift of manufacturing facilities to lower-cost countries, causing a decline in the quality of garments; hence, the lifetime of garments has shortened. In these circumstances, the overall consumption of natural resources increases significantly, and textile waste also grows remarkably. The impact throughout the life-cycle of the product is considerable.

The need for agility in DSM creates natural pressure especially in the upstream part of the supply chain, as the reaction time is rather short. Although some of the

processing can be done in advance or in parallel, agility is ultimately required in apparel production, and as the activities are labor intensive, pressure is ultimately exerted on the workers, in violation of regulations, according to Huq et al. (2014). Lund-Thomsen and Lindgreen (2014) have found discrepancies in commercial and compliance requirements among retailers. From the commercial perspective, buyers demand lower prices, seasonal products, completion of orders within a short time span, and so on, urging them to follow their COC. Lund-Thomsen and Lindgreen have further stated that to meet price points, suppliers cannot pay their workers the minimum wage; to address seasonal demand, they could not provide stable employment year-round; and they are often compelled to make workers engage in overtime work to meet last-minute changes. This difficult reality questions agile practices and FF in their compatibility with sustainability, as it has the immediate impact on workers' welfare. In addition, much doubt has been raised about the effectiveness of the compliance programs, in particular whether there is any perceptible improvement in workers' well-being. Lund-Thomsen and Lindgreen (2014) have found limited evidence that international buyers systematically cut ties with factories in response to their low levels of compliance with social or environmental regulations. Agile practice has created tremendous success for some of the companies, but it is noteworthy that the practice is at best not conducive to sustainability.

3.3.4 Conventional approach for sustainability

Businesses in developed economies on the downstream side, or manufacturers on the upstream side, adopt sustainable practices to some extent from business need or for reasons of CSR. Generally, retailers try to safeguard their reputations from negative media coverage in case of an incident in the supply chain, whereas suppliers find it a competitive advantage to get certified as a socially or environmentally compliant manufacturer. Nowadays, it is a basic requirement of brands or retailers, and hence apparel producers in tier-I typically adopt a social certification system. In addition, increasing regulatory pressure and insistence in various countries regarding environment has compelled firms, especially upstream, to adjust their operations in a sustainable way.

Globally recognized social compliance systems like BSCI, SA8000 (Social Accountability 8000) and WRAP comprise kinds of platforms that retailers or companies can join to make their supply chain socially compliant, and producers find these systems to offer the possibility of proving their compliance levels

through audits and other certification procedures (Mahmood & Kess, 2018). These initiatives often accommodate the demands of NGOs and other stakeholders: for example, Social Accountability International developed SA8000 together with NGOs, trade unions and companies, and the Ethical Trading Initiative was formed by creating a space for dialogue between sectors (Ansett, 2007). The foundational elements of voluntary audit standards like BSCI and SA8000 are based on the UN Declaration of Human Rights, conventions of the ILO, international human rights norms and national labor laws (Social Accountability International, 2014; amfori BSCI, 2018). These social audit schemes measure social performance in different areas of ILO conventions, e.g. child labor, forced labor, protection for young workers, occupational safety and health, freedom of association and right to collective bargaining, discrimination, disciplinary practices, working hours, remuneration, management system etc. Third party audit companies approved by these 'social standard systems' conduct announced, semi-announced or unannounced audit for the suppliers and buying companies can follow their performances in different areas. Both parties receive the written report where the areas of improvements notified, and suppliers are urged to provide remediation plan.

Social standards are not political or scientific discoveries that emerge from concrete problems faced by businesses within a society that has grown increasingly critical of corporate business practices, both locally and internationally (Beschorner & Müller, 2007). They have further clarified that those are regarded as responsible business actions through the voluntary integration of social and environmental concerns not to applied to national governments. Huq et al. (2014) have stated that social sustainability has relatively recently gained importance, which has evolved with the growing concern for ethical problems in the developed world. According to these scholars, various tools are available for the implementation of social sustainability, ranging from a firm's own socially responsible practices or COC to third-party standards and supplier-development programs. Yadlapalli et al. (2019) conducted case-study-based research for supplier selection and found that there is a clear distinction between manufacturers' and retailers' preferences. Naturally, price is the most critical for the suppliers, alongside quality, but from the retailer's side, the most pressing problem was child labor. Lund-Thomsen and Lindgreen (2014) did not find those practices to allow retailers to meet their responsibilities for social compliance in the supply chain. As they have found, social auditing schemes or corporate COC have, at best, brought about limited improvements in workers' conditions, especially in developing-country export industries. Huq et al. (2014) highlight three negative aspects of conventional social compliance

maintenance. First, buyers urge the improvement of the standards, but they do not share the costs of implementation and drive down prices. Second, standards are highly inconsistent, and one supplier must satisfy the requirements of multiple buyers. Finally, banning child labor might save the reputations of retailers, but does not solve the problem according to the spirit of restriction, as the problem shifts to another industry which might be a more dangerous as profession.

Environmental compliance is not as significant in garment manufacturing, but in material processing, yarn production and beyond. According to Parisi et al. (2015) at every stage of textile production, vast amounts of energy, water and chemicals are used to process textiles and apparels, where the main consumption of these energy inputs are due to wet processing (preparation, dyeing and finishing processes). Moreover, the energy required for these processes is responsible for a notable share of the industry's carbon footprint. Naturally, the emphasis is on reduction of the impact, and it is observed that the initiatives are complementary to cost reduction in production. Therefore, the common focus is on reduction of water, energy consumption and chemical consumption, either through new technologies or process improvements. Alkaya and Demirer (2014) found in their review of studies in sustainable textile production that clean technologies, which are often not cheap, require significant investment and may not result in immediate returns. This perplexity is often found as a resistance for using the green technology, since price pressures do not allow further increase. Contrarily, retailers are also under pressure to remain or reduce prices and to increase green value in products or better practice in manufacturing, perceived as the responsibility of retailers. In a consumer survey, Niinimäki (2006) found that, in general, customers are highly interested in greener products, but the majority said that the price, the quality and the esthetic considerations (especially color) are the most important factors in the decision of whether to buy a product.

Esfahbodi et al. (2016) found that the role of suppliers is decisive for the focal firm's overall economic performance, as environmentally friendly suppliers tend to quote higher prices than those comparatively not environmentally friendly. Although the return on investment on modern technology might be a long-term process, firms commonly adopt these as a part of commitment. On the retailer side, reductions in design waste are seen as the most feasible approach to sustainability. Rather than making these reductions in isolation, a collaborative approach is seen as more effective, where the manufacturers often have practical alternatives. As Carter and Rogers (2008) have suggested, some economic benefits can be achieved through better environmental considerations. For example, cost savings can be

made by reducing packaging waste, and in manufacturing, the benefits include reduced health and safety costs, lower recruitment and labor turnover costs resulting from safer warehousing, and better transportation and working conditions.

The span of environmental sustainability is reasonably broad, and it is often difficult for companies to prioritize the tasks that require deep technical know-how and analytical skills. For instance, consider the choice of material. Cotton is a biodegradable and natural material, a good choice in consideration of the end of the product life-cycle; however, it requires a significant amount of resources in its cultivation and manufacturing. In contrast, polyester yarn is a non-renewable resource, but has relatively little impact in manufacturing. Handfield et al. (2002) have found that resolving the trade-offs between product- or process-related sustainability is an important issue because the manner in which they are resolved affects not only the operational definition used for environmental responsibility, but also the screening and assessing of suppliers and their performance. It is worth mentioning that the immediate impact on environment could be reduced by applying the best available technology. In addition, proper measure of the impacts assists the decision makers to comprehend the depth of the problem. Esfahbodi et al. (2016) have discussed preventive measures to mitigate and minimize negative environmental impacts at the source, which could be applied through a suppliers' evaluation and suppliers' environmental certification. Additionally, to intensify and reward the efforts of manufacturing firms that have sustainable production, and to ensure reasonable sustainable development by closing the loop, with a focus on remanufacturing, recycling, and disposal initiatives is seen as effective method. In the FSC, buyers usually impose upon suppliers the requirements for products from the country in which the products enter the market, and suppliers are urged to follow local environmental regulations, which are often quite strict. Azevedo et al. (2017) have found that compliance with environmental laws is costly and time consuming.

Today, various fashion brands and retailers are considering options available to design green manufacturing processes for their products, because decisions made at the design phase greatly affect later decisions to be made in the rest of the supply chain (Parisi et al., 2015). In general, product quality is one of the most important priorities in product design and development. High-quality products are known to be durable products that often last many years and create confidence in a brand. On the other hand, the exposure of a product's fault could seriously damage a brand's reputation. Haas-Kotzegger and Schlegelmilch (2013) have noticed that product-related harms damage a firm's reputation, creating negative inferences about their

products, greater vulnerability to competitors, loss of revenue and market share, and serious damage to brand equity. Moreover, safeguarding quality, retailers are also in a position to design products with greater emphasis on sustainability (e.g. with a timeless design). Niinimäki (2006) has emphasized that designers should focus on the real need, as they can avoid creating throw-away articles, cheap imports and non-durable items. Noticeably, such initiatives are on rise among brands, whereas environmental regulations are increasingly becoming stricter to help reduce environmental impacts.

3.4 Literature review synthesis

This chapter has elucidated the evolving trends in sustainability in the FSC and contemporary challenges for SSCO in order to answer the first research question. It highlights three different areas: namely, the overview of the fashion industry, management methods in value chain and sustainability in the FSC. Figure 8 summarizes the findings of the literature review.

The first section of this chapter elaborated the formation of the FSC and contemporary issues. As the research aims to produce a conceptual model of the demand and supply organization, it is important to understand the composition of the supply chain. The FSC is vertically deep and integrated in terms of dependency. Each tier of the supply chain contains many parallel intermediate processing steps among various parties. The widespread industry and its many different chunks create a complex structure in the industry. According to Cao et al. (2008), coordination in the textile-apparel supply chain is an unresolved problem in practice and in theory, due to long supply pipeline, which makes the lead time long and prompts uncertainty. The textile industry has moved mainly to Asian countries in pursuit of low-cost production, also actuated because of increasing demand for apparel and textile products (Niinimäki & Hassi, 2011). The change in the supply chain and expansion of the manufacturing in relatively low-cost countries has exposed many new complications in addition to the typical challenges.

Recent changes in supply-chain organization and even the formation of the FSC are greatly influenced by the FF and have created remarkable changes in the industry through engineering the supply chain in favor of quick responses. Affordable high fashion's low-cost and relatively low-quality production has reduced the lifetime of the products significantly, driving obsolescence and reducing durability. Suppliers face immense pressure to reduce costs of production and to produce their goods as quickly as possible. In such circumstances, factories

also try to reduce manufacturing costs mainly through cheaper labor and increasing productivity, ultimately resulting in long working hours and unethical practices. Notably, the ultimate pressure is on price reduction, although the costs increase even in those relatively cheaper supply bases. In addition, the pressure for quick response and in-season replenishment have created several difficulties (e.g. uneven production patterns, unhealthy working practices, and faster but unsustainable modes of transportation). Ciccullo et al. (2018) have stated that increases in replenishment frequency increase carbon emission from transportation.

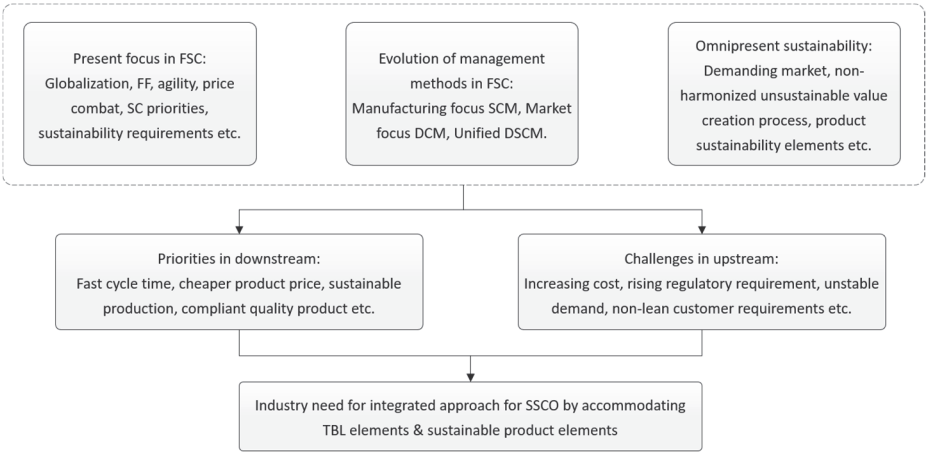

Fig. 8. Literature review synthesis.

The second part explores the evolution in management methods from mass production to DSCM. The FF business model has recently forced the industry to significantly change its management practices, principally based on the concept of agility. Supply-driven or push-oriented production practices have shifted to demand-driven pull practices, with a need for market orientation. The dominance in the industry has shifted from manufacturing towards retail, occurring as retailers or brands that previously had their own production have closed those production facilities and changed to sourcing-driven practice. Value-creation practices have changed to demand-led management processes by which the fulfilment customers' requirements is the main focus. The earlier widely adopted lean practice has changed to agile practice, which is more aligned with market demand, although the element of leanness remains widely practiced in manufacturing. There is a clear gap in priorities in the upstream and downstream side of the value chain in terms

of the supply chains' key factors. Demand-supply chain management is an endeavor to integrate both demand-side and supply-side priorities, although sustainability is not regarded as an entire system element but as individual element.

The third part of the literature review highlights the elements of sustainability considered on the conventional approach, as well as the growing demand for product sustainability considerations. Sustainability as a substantive total approach for obtaining sustainability is yet to be formulated and has a considerable impact on cost. Sustainability, as a concept, typically embraces TBL elements, but for intense dependency on a product for total sustainability, a substantive approach is required. This research argues that product compliance and green considerations should be considered another primary consideration, in addition to TBL. Products designed for sustainability guide the manufacturing process where the suppliers need the capability to pursue. For total sustainability, a product is required to be produced in a sustainable condition (socially and environmentally), considering the impacts across the total life-cycle of the product, with the aim of sustainability. Beyond the thematic material component of sustainability, management's approach is critical: Sustainability must be seen as a systemic property. Azevedo et al. (2017) have found that SSCM has emerged as an approach that combines the general aims of SCM with the goals of sustainability. The conventional approach in the management practices includes stakeholders' demands on the social and environmental side, which can be considered a curative and protective approach rather than an integrative approach. Often, a strategic commitment to sustainability is missing, and it is mainly made based on demand from legislative or stakeholder pressure. Lion et al. (2016) have found that top management support lacking and that the approach to sustainability was very limited, where the aim of an organization was only to be compliant with legislative requirements or to satisfy sporadic requests from the buyer. Non-governmental organizations have often raised the issues from a sustainability perspective, as is often highlighted in media and commonly addressed in the industry. Global initiatives (e.g. SDG) also try to raise the sustainability issues in business, but these initiatives are mainly voluntary for companies.

The literature review has primarily addressed issues related to sustainability in the demand and supply side of the FSC. It has not regarded certain parts of a product's life-cycle (e.g. consumer use and post-consumer processes). In addition, it has not considered raw material processing at the sources or cultivation and corresponding sustainability issues. The literature review has also underlined typical requirements from the brands and retailers and corresponding challenges in

the upstream. These issues are evaluated through case studies, and common priorities will be set for downstream and upstream, which will assist in formulating the model. This research aims to establish an integrated approach for sustainability in SCO, also addressing the lack of harmonization between upstream and downstream.

4 Priorities from the empirical study

This chapter provides a better understanding of the supply chain priority factors and interpretation of sustainability, revealed in literature review in practical context, through empirical studies in upstream and downstream of the supply-chain. The investigation of cases revealed eight supply-chain priority factors (see Figure 6). There are few thematic sub-topics for each key aspect emerged during the review. The topics for discussion and case interview questionnaire were formed based on those sub-topics (see Appendix 1). It is worth mentioning that the intention of the research is to find out the position of product sustainability and total sustainability among other supply-chain factors. The priorities differ in downstream and upstream part of the supply-chain; hence it is important to know the prioritization in different context. The factors also vary even for different product types. The aim of the empirical study is to get a common prioritization of the factors and sub-factors from both demand and supply side.

AHP is used for prioritization of the key supply-chain factors for each case. The same method also used for the prioritization and providing global weight to the sub-factors. Furthermore, the priorities in demand and supply side is observed separately to investigate whether a similarity exists, or they vary notably. The calculation and results from each case presented in tables in Appendix 4 to Appendix 17. The aim is to find the important factors and especially sub-factors, which should be considered in constructing the framework. The results from pair-wise comparison for each case are compared with the average values of upstream and downstream, as well as with the values of entire supply chain. It provides a greater understanding about the position of the overall priorities in the specific case. Product centricity for sustainability scored most. Although it was expected that sustainability will be the top factor and found so for few cases, but overall it was the third most important factor. A comparison of sub-factors between upstream, downstream and overall supply chain is presented in Table 50 (see Appendix 18). As anticipated, most of the sub-factors from product sustainability, general sustainability aspects and service found in top ten. The data analysis in each case also highlights the sub-factors in light of the overall results. The data collection focused on the gathering qualitative data in order to accommodate in the conceptual model, as well as quantitative data through pair-wise comparison. The prioritization helped in setting the logic for inclusion of specific supply-chain activity based on the weight of the factors and sub-factors in the model.

Twelve companies (see Table 1) from both upstream and downstream is studied which are a mix of brand, retailer, manufacturer, SME, large and vertically integrated company etc. As it is noticed in literature review, supply-chain priorities and sustainability dimensions varies in different perspective. In order to accommodate wide range of important topics in the conceptual model it is important to engage enough and critical viewpoints. Hence case companies are selected based on their position in the supply chain, their product type, the company scale, different functions, processing stages etc. The interviewees are also selected who has better knowledge on these criteria (see Table 2). The empirical data is collected in upstream mainly from tier-I suppliers except one which is mainly fall into the category of tier-II although they supply the final product. Few of the cases are also vertically integrated and capture many activities of a tier-II company. No direct tier-III suppliers are analysed. The procedure for case studies elaborated in Chapter 2. The following sections present the cases from upstream and downstream separately followed by a synthesis of both parts.

4.1 Cases in upstream

Nine cases (see Table 1) studied from the supply side in the upstream from Bangladesh and eight of them are manufacturers located to Dhaka or surrounding areas. One of the cases is a local organization in Dhaka of an internationally known brand. Most of the companies are quite large-scale tier-I supplier and some of them are either directly or partially vertically integrated. Most of them have a good network of suppliers for materials and components. All of the direct suppliers are apparel manufacturer except one which is a home textile supplier.

4.1.1 Case 1

The first case organization is a large-scale textile-apparel manufacturing company employs over 15 000 people. They have a vertical setup to provide an end-to-end apparel solution for the customers, ranging from sourcing of yarn to logistics of the ready products. With the help of ERP system, they have streamlined the processes and manage customer orders through efficient capacity planning, allowed them to achieve improved productivity too. They deal with both knit and woven types of products and provides many other services than basic CMT (Cut, Make and Trim) including but not limited to spinning, knitting, dyeing, finishing, printing, cutting, sewing, finishing, packaging etc. Besides, they have component manufacturing,

plastic and packaging product manufacturing, and setup for embellishments works, e.g. embroidery. Their logistic and warehouse business division allow them to provide an end to end service to the clients. In fact, the extensive setup of different functions is more than typical textile-apparel vertical setup which allowed them to serve high-end brands. Among many other clients, they mainly deal with renowned brands, such as Marks and Spencer (M&S), Calvin Klein (CK), Tommy Hilfiger, Tom Tailor, Hugo Boss, Esprit, DKNY etc.

As a recognition of the fairness in the trade, they have achieved FLOCERT as well as BSCI certificate by amfori, 'Ethical Trading Initiative' certificate by Control Union etc. They are also a signatory of UNGC and an organizational stakeholder of GRI. They have achieved TUV certification as a proof of capability for producing quality products. The inhouse textile testing lab is accredited by M&S and Puma. To provide chemically safe product, they have certified for Oeko-Tex Standard 100. Due to their expertise and high focus on cotton products, they have obtained several certificates related to better cotton, e.g. CMIA (Cotton Made in Africa), Organic cotton, Cotton USA, OE 100 (presently, Organic Content Standard) etc. For better practice towards environment, they have managed to get also ISO 14001:2004 (Environment Management System certificate). Few of their establishments are environment friendly LEED Gold Certified. Moreover, they are also belonging to the ACCORD program on fire and building safety in Bangladesh with good progress according to the given remediation plan. Besides many other operations, the company have their own agriculture-based unit with an aim of offsetting the carbon emission by all of their business units.

The main function of the company is apparel production and hence the Chief Operating Officer for garments was interviewed to collect the in-depth information. Furthermore, visit to their manufacturing units provided wider understanding about the company's operations. A detail description of the company by the interviewee provided valuable information for the case analysis.

Data analysis

The pair-wise comparison of the case 1 is made based on the detail discussion on topics and sub-topics presented in Appendix 1. The sub-factors of each factor were also weighted based on semi-structured questions. Table 24 of Appendix 4 presents the analysis of data from pair-wise comparison of each performance factors.

Table 5. Scores comparison case 1 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 1	0.050	0.216	0.097	0.060	0.058	0.097	0.031	0.391
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Sustainability got the highest score (0.391) and product quality was the second most important (0.216). Unlike many other typical apparel manufacturers, they have a clear strategy on sustainability. It is quite evident that the company has invested heavily on achieving different compliance certificates as a proof of their steps on sustainability. The CSR report also presented many CSR activities which shows their intention towards responsible organization. They have achieved independently audited quality certifications and fulfilled the requirements of many renowned brands known for high quality products. Product centricity is found most important factor in the upstream and in the entire chain. Case 1 also recognize it as one of the most important success criteria and invested to provide greater quality products to customers. They have established product testing laboratories and obtained renowned brands' accreditation. The well-established facilities allow them to provide required services to the clients. Service (0.097) is ranked third according to the calculation and naturally so, as service is always an important performance factor. As a manufacturing company, better performance on productivity (0.097) is a must and good planning always assist in achieving efficiency. ERP system allows them to properly allocate capacity between different units. Although lead-time (0.060) is one of the very important performance factors, but case company is doing well due to a vertical setup and as the control in the upstream remains with them. Proper planning also plays a great role here. For the same reason, they have the luxury to be flexible, as they control internally the supply that often, apparel producers depend on external sources. They produce themselves different accessories, e.g. poly bag, button, label, hanger, elastic; which reduce the dependency on the other companies. Because of the possibility to produce many of the components themselves and perform many of the production stages, they also able to produce it in cost (0.050) effective manner. Furthermore, their focus is on the high-quality product and cheap price is not a success factor for them. They also do not depend on the suppliers' performance (0.031) understandably.

Table 25 (Appendix 4) presents the global weight of each performance factors and corresponding sub-factors. As found in the supply chain factors, sub-factors of

product and sustainability found most significant and six out of ten were similar to the upstream list. Production management (0.062) and influence on compliance (0.037) are notable among discrete sub-factors. Better management of production is key priority for such large-scale organization. Complying the customers' requirements is found important as the company deal with top quality brands where requirements are often quite high. The analysis of sub-factor establishes that for such organization, product compliance and social sustainability are significant.

4.1.2 Case 2

Case 2 organization is an established company in apparel sector in Bangladesh, started their textile business unit in 1989 and employs now about 8 000 people. With nine sister concerns, the company has a broad setup of 400 000 sq ft floor space that produces 8 million pieces of garment per year. They often produce quite fashionable products that require further treatment and embellishment works after sewing. They are capable of producing for all customer segments and various product types. The company, principally, a garment manufacturer and specialist in denim treatment and finishing. However, they are well capable of wet treatment of other woven products too. The specialization on embellishment allows them to be an effective supplier of fashionable products. The company is H&M's silver grade listed supplier, mainly for their washing plant. They are also supplier for other globally renowned brands, like: Replay, New Yorker, Esprit, C & A, GAP, Old Navy, Macys etc. Their main export markets are USA, EU and Canada.

It is noticeable that they are working with FF brands and therefore high productivity and ability to deliver in quick succession is the key for their success. Furthermore, they have invested heavily on development of fashion products which combine both innovativeness (in terms of fashion) and sustainability, through their R&D office in Italy. This unique setup helps them to fulfil the need of existing clients and grow further. Their washing plant and one more unit is LEED Platinum certified, a renowned certification for buildings with a low environmental impact. It has developed a unique "start to measure" hardware and software to monitor the resource used throughout the garment finishing process and measure the actual resource consumption and total value-added time per garment.

One of their factories received the certificate for registered training organization by "Bangladesh government" and "ILO" as a part of Ready-Made Garment Center of Excellence project. As a proof of socially responsible

organization, they have awarded WRAP certification and verified through ACCORD for safer production facilities.

The case company is a fashionable product producer and FF brands are in the centre of their target. Such brands are often deal with high volume of products with varieties of styles to deliver in quick interval. It is challenging for the suppliers to fulfil the multifaceted demand and therefore, planning is critical. The Senior Manager of planning and business development is therefore interviewed who has an overall knowledge on the organization and different operations. The company has grown significantly in recent past where improved planning and productivity has a great role.

Data analysis

The pair-wise comparison of performance factors is presented on Table 26 (Appendix 5) which reflects the company's strategy and focus. Product (0.267) received the highest score quite naturally as the company deal with complex fashionable products. Both cost (0.189) and productivity (0.189) found their position next, which are also inter-related. Fast fashion products are often low-cost and hence, they require to produce cost effectively. In general, materials & components are the main cost of an apparel product. After CMT cost is added, very less margin remains for the producers. This company saves costs through improved productivity to remain themselves competitive in the tight cost competition. They also secure profit and order volume with their expertise on fashionable treatments on denim to create trendy product. Fast fashion products need to be replenished in very short intervals as this is one of the main success criteria for retailers. The result of the analysis also revealed the importance of lead-time (0.102) management. The FF retailers are often demanding, and case 2 company has prepared themselves to provide greater flexibility to fulfil customers' requirements. This is also reflected in the calculations, e.g. flexibility (0.089) and service (0.078) found important even compared to sustainability (0.051). Suppliers performance (0.034) found the bottom of the table interestingly although they don't have a vertical setup and must rely on suppliers for materials, components and services. Case 2 has similar focus to upstream in product sustainability, but other priorities differ considerably.

Table 6. Scores comparison of case 2 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 2	0.189	0.267	0.078	0.102	0.089	0.189	0.034	0.051
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

The global weight calculation found only 3 similar sub-factors (see Table 27 of Appendix 5) to upstream average and two of them were from product centricity, e.g. quality management (0.149) and dependency on efficiency factors (0.120). As the case company deal with high volume, they would need to have a good quality management system to maintain required quality in production. Mass inspection of finished products is too expensive and impractical. Standard quality criteria like AQL (Acceptable Quality Level) is practical for such organization, although managing and rectifying faults during production is the effective method for such organizations. This company has high focus on cost and for them management cost (0.105) and processing cost (0.047) is critical. In order to achieve required efficiency, they emphasize on planning and management, but it depends greatly on other factors like workers' skill. In the mass production, skill of workers has great impact not only for the higher production rate, but also for quality. Other management sub-factors like production management (0.049), lead-time management (0.040) and production planning & scheduling (0.040) also important for the company. With the help of extensive management practice, they provide on-demand service (0.050) to the demanding FF customers with their possibility for the readiness for change (0.050). It is apparent from this case that sustainability focus is challenging while serving demanding customers pushes for lower cost, shorter lead-time and greater flexibility.

4.1.3 Case 3

The third case organization is a specialist in knit products, having a composite textile industry, consists of knitting, dyeing, finishing, printing, garment dyeing and washing besides garment manufacturing. The company grow as a large-scale producer from a mere garment maker after established in 1994. Presently they employ around 7 000 people and produce approximately 100 000 garments per day. Having facilitated with all production stages and embellishment work from knitting up to finishing, they are able to serve the mass market retailers and FF brands from

the UK, Continental Europe and North America. With the luxury to accommodate many customers, they are working for known brands like Zara, S.Oliver, Mango, Promod, New Look, Debenhams, Lidl, primark, Monoprix etc.

Due to the requirement for the production of large volume, they focus on verticalization of the processes and improving productivity. Workers have an important role for smoothening operation and improving productivity. By acknowledging the importance, the company invested considerably to improve resource for workers welfare, e.g. workers welfare fund, child care facility, medical facility etc. As a part of CSR activities, they have partnered in two large projects. One project in health sector with the 'Operation Cleft', an international project of the 'Rotary Club of Box Hill Central', Australia and the 'Centre for Disability in Development', Bangladesh. The another one in education sector to provide free education with the assistance of the 'Jaago Foundation', Bangladesh. It is an ISO certified company as well as certified by amfori BSCI, SEDEX and got audited by Walmart. They have achieved the Fair Trade certification and offer also organically grown environmentally friendly cotton products.

Fast fashion retailers or super market retail brands are not only supressing the supply chain for lower price, but also for lead-time. The companies which have a larger setup, often require such clients, in order to fill the capacity throughout the year and ultimately, they fall in the circle of volume-based production. Although the case company was able to grow well, but profitability doesn't support to grow in better pace. General Manger of sourcing was interviewed to learn the facts and conduct the tasks designed for this research.

Data analysis

Like previous cases, product centricity (0.303) is also found most important for Case 3 (see Table 28 of Appendix 6). The results for cost (0.184) and productivity (0.201) also follows the same trend as in previous case. Both case 2 and 3 deal with FF customers and in addition, case 3 also serve for supermarket customers. Such customers also price sensitive and highly dependent on seasonal campaigns. Although the pressure for lead-time is high and leaves less profit margin, but they need to depend on customers who provide large order volume to feed the production lines with enough work. The flexibility (0.096) and service (0.091) are inter-related. Flexibility is seen as a part of service, especially for those buyers who require the last-minute changes and rely on postponement, strategically. Naturally, sustainability (0.049) is not among the top factors, as their priority is limited to

social compliance certification only. Nowadays, this is a general business requirement by the retailers and suppliers find it a must to stay competitive. As the company has own composite setup, their dependency on the suppliers (0.035) are less and lead-time (0.042) can be managed mainly by their own.

Table 7. Scores comparison of case 3 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 3	0.184	0.303	0.091	0.042	0.096	0.201	0.035	0.049
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

The operational focus is also noteworthy in the global weight calculation (see Table 29 of Appendix 6) where five sub-factors from product and service found common from the upstream average list. Production efficiency is critical for the company as dependency on efficiency factors (0.128) scored most. Quality assurance (0.118) and quality yield (0.118) are the second most important find among the sub factors. Quality failure is expensive for the companies with marginal profit and hence, effective quality assurance process and management is essential. Quality yield is the appropriate measure in such cases which provide the leverage for improving performance. Their high priority on production management (0.052) allows them to provide required product quality while keeping the high productivity. When profitability in question in low margin setup, loss due to penalty from the customer is often costly. Understandably, the company saves cost through better management (0.096). Also processing cost (0.037) and marketability cost (0.037) found important in calculation as well as in discussion. Although product compliance (0.046) is found important, but other general elements of sustainability is found relatively insignificant according to the analysis, which is most likely due to their attentiveness on product and productivity.

4.1.4 Case 4

There are companies who think out of the box and go beyond the traditional compliance requirements. The Case organization 4 is known to be the greenest knitwear factory in the world, by establishing green knit apparel manufacturing unit through a ground-breaking project. This project follows the principles of the U.S. “LEED” and the “U.S. Green Building Council (USGBC)”. The company focuses

on intangible compliance e.g. peace of mind along with tangible good practices. A natural lake integrated inside the premise purposefully although there is a natural water management system re-cycling and reusing both rainwater and surface water. In order to comply with the USGBC core standards and guidelines, it has installed digitally calibrated machines essential for utilizing solar energy, CFC free cooling systems, efficient water fixtures, LED lighting, low energy plant etc. in order to minimize the carbon footprint. To meet and exceed energy requirement in their production, it has constructed one of the largest solar energy plants in Bangladesh and the factory has utilized a state-of-the-art skylight system to trap natural sunlight for lighting its facilities.

The company not only set itself in an exemplary position in environmental sustainability, but also able to serve the customers, who are price sensitive. It was possible with their higher-level of planning and operational excellence. It is commonly understood that sustainable production is expensive, and they broke the line of this notion through true example. Therefore, they are successfully partnering with the retailers like Next, Zara, Lidl, Falabella, Mango, Aldi etc. Their emphasis is always on value addition through high quality performance and design. Among many other certifications, the company is also BSCI certified and fulfilled recommendations of ACCORD.

The company has evolved with an exemplary plan and executed it in style, while the Bangladesh RMG sector was under suppression for better compliance practice. The person, who is behind the concept, the Managing Director of the company was interviewed to have a comprehensive understanding about the purpose and consequence of the project. As a pioneer in environmental sustainability in apparel industry in Bangladesh, they could tempt the sustainable fashion brands, although they are able to successfully meet the requirements of customary brands too.

Data analysis

According to the calculation presented in Table 30 (Appendix 7), sustainability (0.436) got the score way far from the other factors, e.g. product centricity (0.170) which is the second most important criteria. It was quite predictable though, based on their emphasis on green effort and something more than environmental compliance. Obviously, product is the second most important consideration, as they have shown that basic apparel products could be also produced in a manufacturing setup with large investment focusing on sustainability. Unlike cases 2 and 3, cost

(0.039) is not as significant. The calculation revealed that service (0.139) to the customer is also one of the top criteria, by which they secure the continuous growth. Flexibility (0.068) is regarded as a part of service and as might be expected, it is also found as next important factor. Due to own setup of knitting and dyeing, they have less dependency on suppliers (0.039) and able to manage the lead-time (0.064). Productivity (0.045) was surprisingly was the least important.

Table 8. Scores comparison of case 4 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 4	0.039	0.170	0.139	0.064	0.068	0.045	0.039	0.436
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Unsurprisingly the environmental compliance (0.219) was the top of the list of global weight calculation (see Table 31 of Appendix 7). The priority of environmental sustainability is such high for this case that the next priority was scored only 0.096. which is also from sustainability. The company considers sustainability as 'very strongly preferred' compared to flexibility. The same score also attained for the significance of product compliance (0.096). This clearly indicates that besides environmental sustainability, they focus on safer production of the products. Six sub-factors from this case matches the ten most important sub-factors in upstream. Customer satisfaction (0.083) from service was the next important sub-factor. They acknowledge the role of customer as found during case study, which can be provided through better service. Both product compliance (0.066) and quality management (0.066) found the next spot. As evident already in the previous discussion, compliant product is important for them for their own reputation and customer satisfaction. Although product compliance enforces through regulatory requirement of physical and chemical safety, the significance of following the specification cannot be avoided where the physical safety considerations should be taken into consideration. Effective quality management at all stage in manufacturing, is the key for production of safer products. Among others, influence on compliance (0.041) from flexibility factor was the only mentionable. This reveals that flexibility might influence product compliance which should be considered prior to being flexible.

4.1.5 Case 5

This case organization is another leading large-scale manufacturer of woven and knit products, established in 1995 and employs over 8 000 people. They can produce over 18 million pieces of different varieties of product annually. They are mainly garment producer and finisher of products through their own setup for apparel production, as well as button production, embroidery, washing, dyeing and printing units. It has an integrated supply chain setup for knitting, dyeing and finishing too. A fully automated effluent treatment plant setup is a symbol of their intention towards modernization, which is also reflected in many other operations including SCM systems, laser technology etc.

Sustainability for the business is the principal focus of the company from the beginning of its journey, and customer care is the utmost important for them. They have a high focus on quality and follow AQL 2.5 for own quality inspection which could be adapted to 1.5 when required. In house product testing laboratory setup allows them to ensure product compliance and quality. They can produce organic and also the fair-trade certified products. In order to measure and grow sustainable practice, they have utilized the 'Higg Index' which is not that common for similar suppliers. As a proof of their focus on social compliance, they have managed to get BSCI and Sedex certificate. Factory buildings were also inspected in accordance with ACCORD. The company is working with FF retailers as well as other regular brands. C&A, H&M, Next, LC Waikiki, Espirit, SPF (Spring Field), SRG, Point O are few of them to be mentioned.

When operational success in question, high level of product centricity might not be complementary. The case company has a balanced approach to maintain sustainable practices by fulfilling the criteria of social and environmental compliance, sustain economically in a competitive market and produce in responsible way. The steady growth indicates the impeccable approach as revealed from the discussion with the Group Director.

Data analysis

Product centricity (0.283) found most important for case 5 as like other previous cases whereas sustainability (0.283) also got the same importance, seen from the pair-wise comparison (see Table 32 of Appendix 8). According to their mission statement, customer care is the most important success factor of the company. Analysis showed that service (0.118) got the next important position in calculation

which is aligned to their intention. Lead-time (0.097) is the next priority as shown in numbers which implies their dependency on the supply chain network, especially for the steps prior to garment manufacturing. Both productivity (0.069) and flexibility (0.064) got almost same numbers, as their importance are quite proportional for this company. Productivity is of course the key for improving profit margin, but the types of customers they deal with, may ask for flexibility occasionally. As the company serve for other customer besides FF brands, cost (0.043) is not one of the most critical factors. Also, the company has integrated various embellishment works to reduce the dependency on the suppliers (0.043). During the study, it is revealed that they are quite confident about their supply chain setup and partner management through infrastructure they established, e.g. IT system and networking with the partners.

Table 9. Comparison of scores of case 5 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 5	0.043	0.283	0.118	0.097	0.064	0.069	0.043	0.283
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Product compliance and sustainability related sub-factors found on the top in global weight calculation (see Table 33 of Appendix 8). Although sustainability and product got the same score in the calculation, but the quality management (0.158) is found considerably higher important topic compared to important sustainability topics, e.g. social compliance certification (0.111) and environmental compliance (0.111). Naturally, for high volume production and lower profit margin, they need to put high focus on managing quality to avoid loss for quality failure. Social compliance is also a primary requirement by most of the customers, and they have prepared their manufacturing units to comply with BSCI, Sedex and completed the remediation required from ACCORD. Their participation in the 'Higg Index' and effluent treatment plant setup shows their commitment towards environmental compliance. On demand service (0.075) found as next important sub-factor. The in-house test facility indicates the commitment and necessity of product compliance (0.070) to secure the fulfilment of requirements to avoid non-compliance of regulations, as they deal with higher volume and financial risk is high. Lead-time management (0.054) and production management (0.044) found as next important topics which are quite inter-related. For managing and executing the production as

planned and scheduled, the supply of raw materials is critical, and hence the dependability on lead-time before production has a direct influence on finished product delivery.

The company's priority on sustainability also reflects when comparing sustainability vs flexibility (0.043), where they keep sustainability on top if demanded to be flexible for a certain instance. The same also asserted with number seen from flexibility's influence on compliance (0.041). It indicates that greater flexibility could pose risk for product and other compliances.

4.1.6 Case 6

Starting its journey in 2000 as a small apparel company, the sixth case company has established itself as another large-scale producer from Bangladesh, employing over 10 000 people, with a production capacity of 5.5 million pcs per month. The composite knit company is equipped with knitting and dyeing-finishing facility to produce 110 000 meters of fabrics per day. The nearly vertical setup allows them to accommodate retailers with higher volume requirement like H&M, Tesco, Zara, Primark, KappAhl, Kohl's, Carrefour, Mango, M&S, Target, Mothercare, Tchibo etc. Although they work globally, but their main markets are Europe, North America and Australia.

Besides garment and fabric production, it has established high quality garment ornamentation facilities including automated rotary printing and screen printing, embroidery, garment washing and dyeing etc. For high-quality assurance and product compliance, it has internal laboratory setup certified by 'ISO 17025:2005'. It has 'OE-100' and 'OE Blended standard' certificate, as well as 'Oeko-Tex 100' certificate for safer products. The factories are socially compliant and certified by Sedex and WRAP with platinum level. It has also followed the remediation process guided by ACCORD. It is a CTPAT (Customs Trade Partnership Against Terrorism) certified organization. The company also invested remarkably in reduction of energy consumption and reduce carbon footprint.

It is not common that companies can deliver high quality products, produced sustainably in large volume, when the margin is low and cost is on rise. Particularly it is a concern for the low-cost products, where raw material consumes the largest part of the cost and rest is allocated for CMT. This case organization has been successfully overcome the challenge by focusing on organizing the supply chain and setting up the units specifically to achieve cost advantage and lead-time reduction. This allows them to remain flexible and provide better service to the

customers. In addition, they have better possibility to invest on greener initiatives which ultimately cuts the cost in long run. The Senior General Manager of marketing and merchandising has shared their long-term strategy.

Data analysis

Sustainability (0.419) is considerably more important (see Table 34 of Appendix 9) than other factors for case 6 and also found most important among manufacturing cases in upstream (see Table 10). The pair-wise comparison is made with the interviewee, who shared the company strategy. The company has put considerable effort on social compliance to achieve different certificates and visible effect on greening the factories and reduction of carbon footprint in logistics and production. Unsurprisingly, product centricity (0.147) has got the next important position due to their effort on the better-quality management and assurance of the 'physical safety properties' through in-house lab testing. The third important factor was lead-time (0.123), which is a bit unusual as they have own composite setup. However, as they work with several different customers who require frequent deliveries around the year, it remains as a priority always in order to provide better service to the clients. Service (0.104) was the next important priority factor for them. To provide better service, it requires to be flexible often and hence, flexibility (0.085) was nearly as important. Among other factors, productivity (0.050) was important which is quite inevitable. Supplier performance (0.042) and cost (0.031) found in the bottom of the list.

Table 10. Scores comparison of case 6 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 6	0.031	0.147	0.104	0.123	0.085	0.050	0.042	0.419
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Three out of ten sub-factors in global weight calculation (see Table 35 of Appendix 9) were from sustainability. Both significance of compliant product (0.166) and social compliance certification (0.166) is found most important among the sub factors. The company had considerable effort on social and environmental compliance, as well as product compliance. Environmental compliance (0.067) was third sub-factor from sustainability. There is a notable gap between the next sub

factor and the first one. Although the score was not as high, the next sub-factor quality assurance (0.077) and importance of quality management (0.031) depicts the expanse of their commitment about product compliance. Among the six common sub-factors from the upstream list, customer satisfaction (0.066) was the last one. It is part of their flexible approach as their customers are very diverse, ranging from FF to quality fashion brands. The case company has learned to be flexible when demanded and the supply-chain is organized to deliver the demanded service. Hence, readiness for change (0.054) justified to be an important consideration for them. Sub-factors non-similar to the top average values from upstream are mainly the highlight of management practices, e.g. lead-time management (0.048), production planning & scheduling (0.048) and production management (0.032). There are numerous issues connected to sustainability and when a company wants manage operations sustainably, it is critical to have better management practice in place.

4.1.7 Case 7

Established in 2003. the case company 7 has secured its position as an effective knitwear product supplier and grown as a large organization, consists of 20 sister concerns. It has the capability to deliver 1.3 million pcs monthly and have a workforce of 6 500. It has modernized production management system to deliver high productivity and focuses on preventing quality flaws at the source. As a recognition of better-quality management, they have achieved 'ISO 9001:2000' certificate. The company focuses on fulfilling the general requirement of product quality and social compliance to provide the required service to the customers. Their main export markets are Europe, UK, USA presently. The main customers are Charles Vogele, Etam, Okaidi, C&A, Lindex, Stradivarius, Jules & promod, Matalan & Mother Care, Wall-Mart, Sears Kmart, Next, Lidl, Aldi, Disney and few others.

In its endeavour towards composite setup, they have established knitting, dyeing and printing facilities. As required by its customers, it has achieved few social certifications including amfori BSCI, SEDEX, WRAP etc. Besides, they are also audited by social compliance audit program by the brands, e.g. Inditex, C&A, Primark etc. The company got 'Oeko-Tex 100' certificate. It has completed the remediation requirements from ACCORD.

For the general manufacturing organization, it is not always required to be a pioneer, but emphasis can be exerted in mastering the core competence and

upgrading the capability to sustain in challenging circumstances. The case company, as serving for the supermarket and FF brands, the smart way to grow is concentrating on the requirements by the customers and capitalize on their core competence. The findings from the analysis together with their Managing Director presented in section below.

Data analysis

Unlike most other organizations their focus is also on sustainability (0.315), which is already quite high in the scale of 0 to 1 (see Table 36 of Appendix 10). They have a lot of emphasis on social compliance and as a result, passed many different audits to achieve different certificates which is a proof of their effort. They have achieved also the certificate for quality management, indicates their seriousness towards producing better quality products. The second highest score from the pair-wise comparison was 0.234 for product centricity (see Table 11). Quite naturally, service (0.145) is another important factor for the types of customers they handle, who may look for greater flexibility. Other factors than the top three were not as significant in calculation. Productivity (0.079) is a natural important criterion for their economic sustainability and with the help of their own material production, they can achieve some cost benefit as well as reduce the lead-time (0.074). The own control of the process prior to CMT allows them to be flexible (0.069) to some extent. Cost (0.052) is not as significant compare to other factors for the same reason and also less dependency on supplier (0.033).

Table 11. Scores comparison of case 7 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 7	0.052	0.234	0.145	0.074	0.069	0.079	0.033	0.315
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Sustainability was quite dominant in pair-wise calculation and the sub-factors of sustainability also dominant in global weights list (see Table 37 of Appendix 10). Three sub-factors from each, sustainability and product centricity, found as top sub-factors. According to the calculation, social compliance certification (0.164) is on the top, quite understandably, because of their achievements in passing through multiple audit processes. Claim handling (0.092) was the second most important

among the sub-factors, interestingly, which hasn't been found as a priority in other cases. It might indicate that in case of a claim from customer, they resolve the problem with high priority, as a part of better service. Quality assurance (0.091) and product compliance (0.091) is nearly as important because the company like to assure the quality and compliance of the product in production stage already in order to avoid any kind of failure, possess a financial risk from customer claims. From the next important sub-factors, two more element from sustainability scored the same. The score of significance of product compliance (0.063) assert once again the importance of sustainable products and, sustainability stays ahead when comparing it with flexibility (0.063). Result shows that readiness for change (0.044) is the main priority for flexibility. Production management (0.051) is the priority to improve the productivity, because they depend on high efficiency in production for the higher profit margin. Customer satisfaction (0.037) and quality management (0.036) was among other mentionable sub-factors and the significance of both has arisen in discussion before.

4.1.8 Case 8

This case organization is unlike other seven cases which is a home textile manufacturer. The company has started its operation in 2010 and employs around 1 200 people, with the vision of offering high quality and eco-friendly products in competitive price. It has a vertical setup, starting from weaving to finished products and consists of high-quality equipment for warping, sizing, weaving looms, dyeing and finishing. The company has expertise on yarn dyed jacquard terry products among many other different types of terry products. The production capacity is 20 ton per day. They have achieved the 'ISO 9000' certificate for high level quality management.

The company has an environmental policy to reduce the environmental impact by minimizing the pollution at sources, optimizing resources consumption by maximizing recycling and reuse. As a step on better transparency, the company has listed their supplier publicly. The high focus on sustainability and better service allows them to export to Europe, UK, North America, Turkey etc. Among many other suppliers IKEA, Carrefour, Walmart are some of the names to mention.

The priorities and challenges of this case organization could be different than others due to difference in the type of the product. The company is also trying to establish a new business line in the textile sector for Bangladesh. As a pioneer in the specific product category, they were able to successfully pass the initial hurdles

although it is not over yet. Based on the interview with the Head of marketing of the company and case analysis, it is established that the priorities are not substantially different and more correspond to the priorities of textile production than apparel production.

Data analysis

Case 8 also has the similar importance on product centricity (0.258) and sustainability (0.242) like other organizations in the upstream (see Table 12). The company produces different kind of products than other cases and as a forerunner in home textile product category, they are likely to prove their expertise in producing such products. The pair-wise comparison (see Table 38 of Appendix 11) of the performance factors found the importance of customer service (0.171) and lead-time (0.114) for this case. As a growing company, they have to provide quality products and better service to attract more customers. They have integrated many processing steps to reduce the lead-time as a part of better control of quality and providing better service. They have found that customers are often demanding and variable in requirements. In order satisfy their needs, flexibility (0.066) is key as they need to do something different than standard practice. Cost (0.054) and productivity (0.051) is on the same importance level which are better point of focus after the steady business. Supplier performance (0.044) was not as significant as they only depend on raw material supplies and most of the manufacturing stages are in their own control.

Table 12. Scores comparison of case 8 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 8	0.054	0.258	0.171	0.114	0.066	0.051	0.044	0.242
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Seven sub-factors from case 8 found similar to top ten average upstream values (see Table 39 of Appendix 11). Although there was a possibility to have different priorities for this case as it is different than other cases, but the priorities found almost similar. Three sub-factors from each factor, product and sustainability, found in the top of the list. The environmental compliance (0.126) is on the top despite of their high priority in product. But as the production process is chemically

intensive, the impact on environment also high. The second top sub-factor was customer satisfaction (0.109). As described earlier, at the present state of the company, business growth can be attained through higher satisfaction of customers. From product centricity perspective, quality assurance (0.101) and quality yield (0.101) scored the same. High product quality is the gateway for getting new customers and market and hence quality assurance is important as well as high yield in quality is crucial for internal performance measurement. The production length depends on the design complicacy (0.059) which has a direct impact on lead-time. Significance of compliant product (0.049), especially chemical safety is higher as the products made to be used for skin contact and might be used as child care item. They also consider sustainability as slightly more important than flexibility (0.049), as it is found in pair-wise comparison too. On demand service (0.044) from service and readiness for change (0.042) from flexibility is inter-related and important for better service. Quality management (0.039) was another important sub-factor and it is evident with their achievement of certificate for quality management.

4.1.9 Case 9

The last case organization in the supply side is a sourcing office of a reputed and well-known brand from Europe. The Dhaka office is operative from 2004 and handles significant amount of sourcing activities. As China continues to become more expensive, the Bangladesh organization has possibility for further growth to source more products. T-shirts, sweatshirts, sweaters, woven bottoms, denims, men's shirts, ladies' blouses and jackets are among the main sourcing items from the country.

The company has a strong policy in ensuring compliance in order to ensure that a supplier pass the basic threshold before starting co-operation. The brand requires partnership approach from the suppliers, with a capability of operating round the year ceaselessly for twelve seasons. The requirement is something more than the basic requirement for compliance, capacity and capability. They audit the entire supply-chain even the sub-contractors of the suppliers. The production quality also controlled and monitored by own quality controllers.

The case organization has different operational priorities and focus compared to the other eight previous cases, as their activities are concentrated on sourcing. Besides commercial operation, one of the main tasks is to monitor the social compliance as a part of their sustainability approach. As it makes more sense for this study, the Sustainability Manager of the organization is interviewed.

Data analysis

The calculation of factors for case 9 revealed that sustainability (0.427) is the most significant (see Table 40 of Appendix 12) and considerably higher in priorities compared to other factors (see Table 13). As a European brand, sustainability is nourished in their culture and naturally the requirements are tighter. The sourcing office is responsible for ethical sourcing, as well as assure the product quality. Hence, product centricity (0.229) is found as second important priority. The quality assurance team ensures proper workmanship and checks whether products comply the guideline given by the design and product management. The fashionable brand is highly dependent on the trends and seasonality which may cause late changes. The flexibility (0.096) is important to fulfil the variable demand. As the brand work with short-cycles and frequent deliveries, lead-time (0.084) is important too. Better service (0.060) is perceived as the fulfilment of requirement. Cost (0.044) effectiveness although not as crucial, but it is a natural priority to source their product in competitive price. Efficiency (0.032) is not a main focus for them, but surprisingly supplier performance (0.029) was the least important.

Table 13. Scores comparison of case 9 with upstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 9	0.044	0.229	0.060	0.084	0.096	0.032	0.029	0.427
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Global weight calculation of sub-factors (see Table 41 of Appendix 12) revealed that, all of the sub-factors of sustainability are important. The top two scores, significance of compliant product (0.222) and social compliance certificate (0.086) indicates the practical approach for sustainability. Although the company has priority from the downstream point of view, but still most of the factors and sub-factors aligned with the upstream priorities. From the calculation, it is seen that seven sub-factors were similar to the upstream's top ten sub-factors. They keep sustainability ahead of flexibility (0.086) in comparison, as sustainability is most important criteria for them. Among the sub-factors not common from the upstream average values, readiness for change (0.061) is mentionable. This is a very general expectation from the demand side. The local organization also responsible for controlling the quality and hence, quality assurance (0.060) found importance in

the priority list. Not too many sub-factors deserve further analysis after lead-time management (0.047), because of the insignificant scores in the global weight list. Lead-time management is of course important as they need to follow it up in their supply chain for the timely delivery and replenishment.

4.1.10 Upstream case data synthesis

In order to comprehend the general importance of the factors in upstream, the average values from all the cases were prioritized with pair-wise comparison presented in Table 42 (Appendix 13). The average value of product centricity (0.298) is the most important factor followed by sustainability (0.144). For all the nine cases (see Table 14), product was the top most or at least second most important criteria. In the supply chain average also, it was the most important factor (0.309). Although the importance of sustainability varied case to case, but importance of product sustainability was quite consistent. The global weight calculation of the sub-factors also found the significance of 'product compliance' where 6 out of 9 cases emphasized on it along with the importance of quality assurance (4 out of 9). Producing the right product according to requirement is the key success factor for a manufacturer. This also includes the assurance of regulatory requirements in order to secure business from unexpected recall. Different issues focusing on product includes: quality assurance and yield, sustainable raw materials, physical and chemical requirements etc. These issues are also grabbed from the qualitative analysis. Naturally 'product' remains on top of the list. Product is seen merely as a 'product' by the suppliers, where it is not seen from sustainability point of view. And therefore, 'sustainability' as a standalone factor is significant consideration, which is seen as compliance requirements from the demand side. The importance of sustainability varied among cases where for some cases it is a very high priority, while for other cases less important factor. However, for 5 out of 9 cases in upstream, sustainability was the most important and second most important in the upstream.

Table 14. Comparison of values of factors with upstream and supply chain average.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 1	0.050	0.216	0.097	0.060	0.058	0.097	0.031	0.391
Case 2	0.189	0.267	0.078	0.102	0.089	0.189	0.034	0.051
Case 3	0.184	0.303	0.091	0.042	0.096	0.201	0.035	0.049
Case 4	0.039	0.170	0.139	0.064	0.068	0.045	0.039	0.436
Case 5	0.043	0.283	0.118	0.097	0.064	0.069	0.043	0.283
Case 6	0.031	0.147	0.104	0.123	0.085	0.050	0.042	0.419
Case 7	0.052	0.234	0.145	0.074	0.069	0.079	0.033	0.315
Case 8	0.054	0.258	0.171	0.114	0.066	0.051	0.044	0.242
Case 9	0.044	0.229	0.060	0.084	0.096	0.032	0.029	0.427
Upstream average	0.108	0.298	0.137	0.101	0.094	0.079	0.039	0.144
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Service (0.137) is important from supplier perspective as naturally they would like to keep satisfy the customer for the long-term business relationship. It was the third most important criteria in the upstream. Cost (0.108) is somewhat important criteria in the upstream but not as significant. There are considerable number of companies in the upstream deal with FF retailers or supermarket brands. The results also found that the companies which deal with such customers has relatively less importance on sustainability and more focus on product compliance, service, flexibility etc. Case 2 and 3 are good example where they deal only with the FF and supermarket brands and sustainability was among the least important factors. Understandably, product cost appears as an important parameter, due to the heavy pressure on product price from the retailers. Lead-time (0.101) is important criteria throughout the supply-chain in all operations and especially significant for those deal with FF. Flexibility (0.094) is not as critical for the suppliers, as it might have an influence on their productivity (0.079). However, this is not a big concern when they deal with large volumes. Often varieties of styles and small batch sizes create direct impact on efficiency. Supplier performance (0.039) is basically found least important as many of the case companies have own tier-II operations, e.g. material production.

4.2 Cases in downstream

Three case companies in the downstream have different setup for the supply of their merchandise. All of them have their own brands and handles design and product

development of their own. The case companies were from Finland and all of them have outsourced or nearshored the manufacturing and other major activities.

4.2.1 Case 10

The first case organization from the demand side is a kids-wear retailer with long brand history and all of their manufacturing is outsourced, although they have historically own productions in Finland. The company produces wide range of products for children and sell through own retail stores, online stores and wholesales. The sales scope has widened to international market significantly in recent past. The brand is known for the high-quality products and it is ensured through comprehensive R&D effort as well as design from Finland. Besides sales and marketing, the supply chain and sourcing function also in their own control.

The dynamic CSR practice ensures the social and environmental practice in the supply chain. The social sustainability is ensured by amfori BSCI membership and through their own audit program for tier-I suppliers. They also conduct environmental audit program for tier-II suppliers to restrict use of harmful substances in the material production. The product compliance is extremely important for them as a part of product sustainability, as they operate globally and require fulfilling the regulatory requirements of different markets. Besides complying the different country regulation, they also conduct tests to ensure physical properties as a part of commitment for high quality product. The own quality control team in the supply chain also ensures the product quality of the required level.

The case organization has been growing in recent past significantly and therefore they have different kinds of challenges to manage the positive growth. It is particularly challenging in the supply side where manufacturing and raw materials cost is on the rise and maintaining high product quality is challenging. Although strategically sustainability is in the top, but operationally some other supply chain factors get prioritised in the present circumstances. In order to obtain a better understanding about how they are managing their growth, the Sourcing Director of the company has been interviewed.

Data analysis

The calculation of factors for case 10 (see Table 43 of Appendix 14) found that flexibility (0.318) is the most important factor (see Table 15). It could be assumed

that sustainability or product compliance are more important, but from the practical point of view the scores are not odd. Due to their high level of growth and access to the new markets, they require more flexibility from their suppliers for capacity, assortment, delivery and maintaining product quality. Product centricity (0.217) is naturally very important for their high focus on product compliance and quality. Lead-time (0.127) improvement is one of their focus in order to achieve competitive advantage, but due to the wide varieties of product and various suppliers from different geographical location, it is not always easy to maintain. They must depend highly on the suppliers to deliver high-quality products to the customer on-time. Supplier performance (0.118) is therefore, significant for their operational success and they expect high quality service from their suppliers too. Service (0.085) from their suppliers in the supply chain is critical for them to provide the same for their clients. Suppliers' high productivity also has an impact on their efficiency (0.060) due to the natural dependency on their performance. Although they have focus on sustainability (0.045), but it doesn't reflect in the numbers because of their recent priorities on operational factors. Cost (0.031) is not a top criterion for them due to their high focus on quality products.

Table 15. Scores comparison of case 10 with downstream and supply chain average. value

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 10	0.031	0.217	0.085	0.127	0.318	0.060	0.118	0.045
Downstream average	0.039	0.306	0.138	0.091	0.181	0.061	0.085	0.100
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

The priorities of the factors for case 10 differs from the downstream average. However, among the priorities of sub-factors (see Table 44 of Appendix 14), 7 out of 10 are common to downstream average. As flexibility scored highest from the factors, sub-factors of flexibility are naturally rule the list. Influence on compliance (0.203) is high as their high focus on product compliance as well as other compliance issues, like social and environmental compliance. Product compliance (0.122) is the next most scored sub-factor, which again establishes their focus on product. As found in pair-wise comparison, lead-time is one of the areas where they want to put more focus and hence lead-time management (0.083) is also seen as significant from global weight calculation. Almost same score is obtained for the readiness for change (0.082) as flexibility is what they expect from their suppliers

and in their own operations too. To achieve better control in the SCO, they expect enough transparency and control in the supply chain (0.075). The transparency is also a pre-requirement for the effective quality assurance (0.057), as they control the quality in manufacturing through own inspection. High quality product is one of the basic aspects of customer satisfaction (0.053) and the company want to satisfy its customers by maintaining it. Therefore, they have also focused on product category (0.039) which is the area of their core expertise. Among the other important factors, influence on efficiency (0.033) and assurance of compliance (0.030) is mentionable.

4.2.2 Case 11

This case organization is relatively new in the business and started with the concept of high-quality safe clothes with fearless design. They intended to promote sustainable clothing which are durable, made from better materials (organic) and chemically safe (e.g. Oeko-tex 100 certified). The product ranges created for kids as well as products for women. They mainly sell through online channels and wholesale through some retailers in the Scandinavia. The constantly growing company is still in very small scale where they are struggling on formulating the SCO and improve the manufacturing and delivery process.

The company has near shore manufacturing strategy with the aim to produce all the materials and products in Europe. Due to the constant growth and increased demand, they need to increase production capacity. As the present suppliers have limited capacity, they also require new suppliers to fulfil the demand. Besides, they are also focusing on lead-time improvement due to market demand. They are in advantageous position to achieve the competitive benefit of delivering products in quick time and succession even for very low volume. The company do not put special focus on social compliance as the products are made in Europe and expected that the compliance with local requirements are adequate to maintain the workers right. The environmental compliance in the supply chain is also not an area of their concentration due to the same reason and they have less visibility on that part.

The company has reasonable sustainable focus and in manageable scale until now, because of their small scale of operation and extent of supply base. As they are growing in fast pace, the focus is definitely to manage the growth where operational improvement would be critical. The Director of Development who handles both the production and operations, has interviewed and performed the pair-wise comparison consequently.

Data analysis

The priority factors found in calculation (see Table 45 of Appendix 15) represents the analysis made for the company. The aim of the company is to produce high quality safe products and it is naturally expected that the product centricity (0.322) will remain in the top. Although they do not have major activities to maintain or improve sustainability (0.240) in their supply chain, but it is clearly their focus area as learned from the interview. The main limitation is in the resource and expertise, but they will keep it as an important focus area. Although they have high sustainability focus, but product sustainability is still top criteria, as they can communicate better about the sustainability through products. From the other key factors, flexibility (0.160) found significant in their operation. Due to the small size of operations, customer types and wider range of products and SKUs (Stock Keeping Unit); they require greater flexibility from their suppliers which is essential to provide good service. They also expect good service (0.096) from their suppliers to fulfil the demand from clients. The customers type they deal with, is different than the traditional retailers and the type of service required is also a bit different. Supply of products, in quick time and small quantity, is one of the success factors in their business and hence lead-time (0.056) is critical. For providing the better service and maintaining lead-time, they need better performance from the suppliers (0.056). As they deal with small size suppliers and restriction in the capacities, better productivity (0.046) also has a direct influence on their efficiency in operations. Cost (0.025) is not as significant for them, quite naturally, because of their aim for high quality products.

Table 16. Scores comparison of case 11 with downstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 11	0.025	0.322	0.096	0.056	0.160	0.046	0.056	0.240
Downstream average	0.039	0.306	0.138	0.091	0.181	0.061	0.085	0.100
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Nine out of ten sub-factors in global weight list are similar to upstream average values (see Table 46 of Appendix 15). Supplier management (0.041) is the only one not common from the list and this is certainly a high focus area for them as found in the case analysis. They have high dependency on suppliers for managing lead-time (0.037) as they have relatively very small window for delivery of merchandise.

The high score on product compliance (0.167) assert again the importance of product sustainability. Even in the sub-factor of sustainability, significance of compliant product (0.134) remained in the top. From the operative side, the readiness for change (0.104) by the suppliers is another important consideration for their agile approach. Both quality assurance (0.065) and quality yield (0.065) scored the same and not to mention the importance of quality again. As found earlier, service is an important parameter for their success in the business and therefore, customer satisfaction (0.061) is naturally an important measure of the performance for them. The next sub-factor in the list is environmental compliance (0.060) and due to their supplier base in Europe, they have a better possibility to maintain it. Another sub-factor from the flexibility, the influence on compliance (0.045) assert the need of greater flexibility in the supply-chain.

4.2.3 Case 12

There are not too many companies in this region, who have been able to retain their manufacturing in the time of global shifting of manufacturing towards Asia. The long history in manufacturing and expertise in specific product category, allowed the case company to sustain till date, albeit they have mainly a nearshore manufacturing setup. The company serve for local market, with their product range starting from denim, non-denim items and outdoor products among few other product categories for men and women. They have few of their own brands, which are quite well known in Finland among consumers.

Their main emphasis is on sustainable production. The wet processing unit is in the centre of environmentally friendly production and they are one of the early adopters of sustainable process, e.g. robotic brushing, laser treatment, ozone treatment etc. The materials and components are mainly sourced from Europe and the final apparel production is in their own control. All the materials selected for the collections are chosen from the sustainability point of view where they can do the final wet processing with less impact on environment. Due to their strategic presence of close to market, they can provide high quality agile service to the customers.

The case organization has passed through many tough periods in its journey, where they have survived with the competence they achieved with time and, for the competitive advantage of their position in the market. Besides, they have also sustained by confronting the challenge of cheaper products from low-cost manufacturing countries. Although local manufacturing is admired, but masses

consumers are not willing to pay more, only because of the fact that, those are produced in Europe and high-quality. The company's Managing Director is interviewed to learn about their operational success to retain manufacturing in this zone.

Data analysis

The pair-wise comparison of case 12 (see Table 47 of Appendix 16) found sustainability (0.273) as a most important factor. The priorities of the factors (see Table 17) are quite aligned to the priorities in the upstream as they also have own control on manufacturing. For example, previous cases in downstream might not confront the practical challenges related to sustainability and hence, it was not the top priority for those. But case 12 have to adapt their operation according to strict environmental regulations, e.g. environmental permit for wet processing. Importance of better alternatives in manufacturing and the tough business condition compel them to put more focus on it. Very naturally, product centricity (0.246) came up as another top priority, as they sustain in the tough competition with the high quality and safe products. While sustainability and product, together, shared the big portion (0.519) of the global weight, service (0.133) has found the third top place. Flexibility (0.116) was the next important factor as it is naturally expected from their suppliers. Among other factors under 10% score, lead-time (0.072) and supplier performance (0.063) are found insignificant in their operation. Although the lead-time for the supply of material is important for them, but lead-time is not as critical as their materials are mostly coming from Europe or near. As they have their own manufacturing, the dependency on supplier is relatively less. Productivity (0.054) has surprisingly got very less importance, although, they really need high productivity to save cost. Cost (0.043) was the least important from the list.

Table 17. Scores comparison of case 12 with downstream and supply chain average value.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 12	0.043	0.246	0.133	0.072	0.116	0.054	0.063	0.273
Downstream average	0.039	0.306	0.138	0.091	0.181	0.061	0.085	0.100
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Global weight calculation of the sub-factors (see Table 48 of Appendix 16) found that seven of those were similar to downstream average values. The unmatched factors are similar to upstream priorities. From the calculation, environmental compliance (0.154) got the top score due to their high focus on chemical and environmental safety and stringent local and EU regulation. Same as in the pair-wise comparison of factors, sub-factors of quality have also received high scores. Quality assurance (0.049) is generally significant for a 'demand side' organization, but quality yield (0.128) and quality management (0.049) is typically important factors for manufacturing companies. Customer satisfaction (0.085) was the third most important sub-factor from the list. Naturally, the company go a bit extra mile to satisfy customer by not only with the better-quality product, but also with quick delivery in small quantities with the help of 'never out of stock' products. Influence on efficiency (0.074) for greater flexibility is a concern, as efficiency in production is not an option but mandatory. Significance of compliant product (0.072) is a natural requirement because of their focus and possibility. Lead-time management (0.041) is important in their supply chain, as quick delivery in quick succession is one of their principle success factors. Transparency and control in the supply chain (0.040) is required to ensure product compliance. Production management (0.034) is another mentionable score among the other sub-factors which were not as significant.

4.2.4 Downstream case data synthesis

The average values of the factors of the downstream cases (see Table 49 of Appendix 17) show the significance of product compliance. Sustainability is the fourth important criteria in downstream SCO. During the interviews and case studies, sustainability is found as very important criteria, both strategically and operationally for each case. But as the pair-wise comparison is made based on the practical importance of the factors, the operational priorities and challenges influenced the comparison and scoring. Product centricity (0.306) is also the top priority from the downstream average, likewise the case studies. This is an important finding of the case analysis as product sustainability found as top important criteria in downstream, upstream and supply chain averages. Although, the companies generally have a strong sustainability focus, but the practical approach has often governed them towards product centricity and focus on other issues like flexibility (0.181) and service (0.138). Flexibility (0.181) was not as important in upstream, but this is key for the retailers as they deal in volatile

circumstances and demand it from their partners. While the total of earlier two factors (product centricity and flexibility) received more than half of the weight, service (0.138) is the among the top of the other factors from the list. The apparel supply chain is agile in nature and flexibility is naturally one of the most important service criteria that the retailers expect from their suppliers.

Table 18. Comparison of values of factors with downstream and supply chain average.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability
Case 10	0.031	0.217	0.085	0.127	0.318	0.060	0.118	0.045
Case 11	0.025	0.322	0.096	0.056	0.160	0.046	0.056	0.240
Case 12	0.043	0.246	0.133	0.072	0.116	0.054	0.063	0.273
Downstream average	0.039	0.306	0.138	0.091	0.181	0.061	0.085	0.100
Supply chain average	0.095	0.309	0.140	0.102	0.108	0.076	0.046	0.125

Sustainability (0.100) is not found as a standalone significant consideration as sustainability issues are highly considered and integrated in the products already. It is quite evident from the activities in third case in the downstream. It is also considered as a natural practice in their own operation and expected the same in their supply chain too. Lead-time (0.091) has similar level of importance to upstream average (0.101) as it is a common priority for most of the parties in the supply chain. Supplier (0.085) dependency is high in the downstream, but was not as important for the upstream cases as they have often vertical setup, at least the cases analysed in this research. Case 10 source all of their products from Asia and it has greater dependency on supplier (0.118), but for other two cases it is not as significant, because of own partial manufacturing and near shore sourcing. The SCM has a greater role and the success greatly depend on selecting the right partner where product category and required quality level has a role. Cost (0.039) has significantly less importance in the downstream compared to upstream (0.108).

5 Substantive approach for managing sustainability

This chapter presents the proposed conceptual model for a substantive approach to managing demand and supply sustainably, based on the learnings from the literature review and case studies. The word 'substantive' is defined as 'involving matters of major or practical importance to all concerned' (Merriam-Webster, 2019). This research aims to define a substantive approach in FSC for managing demand and supply in a sustainable way. As the word 'substantive' suggests, the conceptual model will have practical importance for the major issues initially aggregated through literature review and identified through research. Empirical study has provided further perspective on these, especially different views on upstream and downstream. The prioritization of supply-chain factors and sub-factors enabled the identification of the key issues, mainly from the sub-factors, to be accommodated in the proposition. The reliability and validity of the study presented at the end.

Various contexts of SSCM and product sustainability are revealed through literature review, empirical study, and the researcher's experience in the FSC. It is important to categorize these according to strategic importance, where thematic elements should be separated from planning and operational elements. Theoretical review has highlighted the importance of product sustainability in parallel to TBL elements. Product elements appeared in discussions in a dispersed manner and in association with TBL elements. Furthermore, product sustainability elements are disguised under quality and regulatory requirements. All of those elements are organized hierarchically into strategic, planning and operational levels in Chapter 5.1. The concept of forming a sustainability hierarchy originated from the necessity of filtering and classifying the elements in organized manner. The strategic-level elements are thematically collected from the theoretical review, whereas planning-level elements are the product of literature and Case studies which are further elaborated for operational-level implementation. The hierarchy will serve by providing the useful elements in the conceptual model, where strategic elements will work as a thematic base for construction, and elements from the planning and operational levels will be highlighted as key considerations for SSCO. The SSCM requires the integration of the sustainability elements, as well as the supply-chain operational elements. The prioritized operational elements, determined through global weight calculations from the cases, will be included in the conceptual model.

The construction of the concept starts by presenting the sustainability hierarchy. The model consists of the elements important for managing demand and supply for

sustainability and circularity. The requirements in the downstream and challenges in the upstream are presented separately. The synthesis of these forms the general structure of the proposition. In addition to major considerations for SSCO, a value creation proposition through the substantive approach is also presented. The elements and activities presented in the model have a direct or indirect impact on any or all of the four pillars from the sustainability hierarchy. The framework considers that the brand and retailer engage in design and retail activities and control all other activities except manufacturing. The model keeps other operational elements out of scope for DSM which have no significant impact on sustainable operation.

5.1 Elements of the sustainability hierarchy

Sustainability is a comprehensive term encompassing multifaceted topics. The extent of sustainability is rooted in a company's strategy up to the operational level of activities. The proper apportionment of various elements of sustainability and operations according to the significance is used to set priorities. The sustainability hierarchy is formed by various strategic-, planning-, and operational-level topics divided into three layers. Elements of the social, environmental and economical sustainability perspectives presented in columns are set into different layers along with the heuristic product sustainability perspective. The total sustainability hierarchy is presented in Figure 9.

At the strategic level, the motive and aim of each spearhead of sustainability determines the sustainable business goals of the organization. Generally, upper management develops the plan at a strategic level, as they have a better understanding of the whole organization. Moreover, they are also knowledgeable about stakeholders' requirements. The organization's view on sustainability and CSR strategy at a higher level represents the important material topics which have a greater impact on their business and are crucial from the stakeholders' perspective.

Strategies are defined for the whole business, and usually they encompass a longer time horizon. The planning level outlines the strategies and translates them into propositions to be implemented at an operational level, providing priorities. The criteria are set for each important material topic at this level, focusing on the feasibility of implication in the operations. The operational level considers all the minutiae of material topics. The method of implementation of each priority and measuring procedure is defined at the operational level.

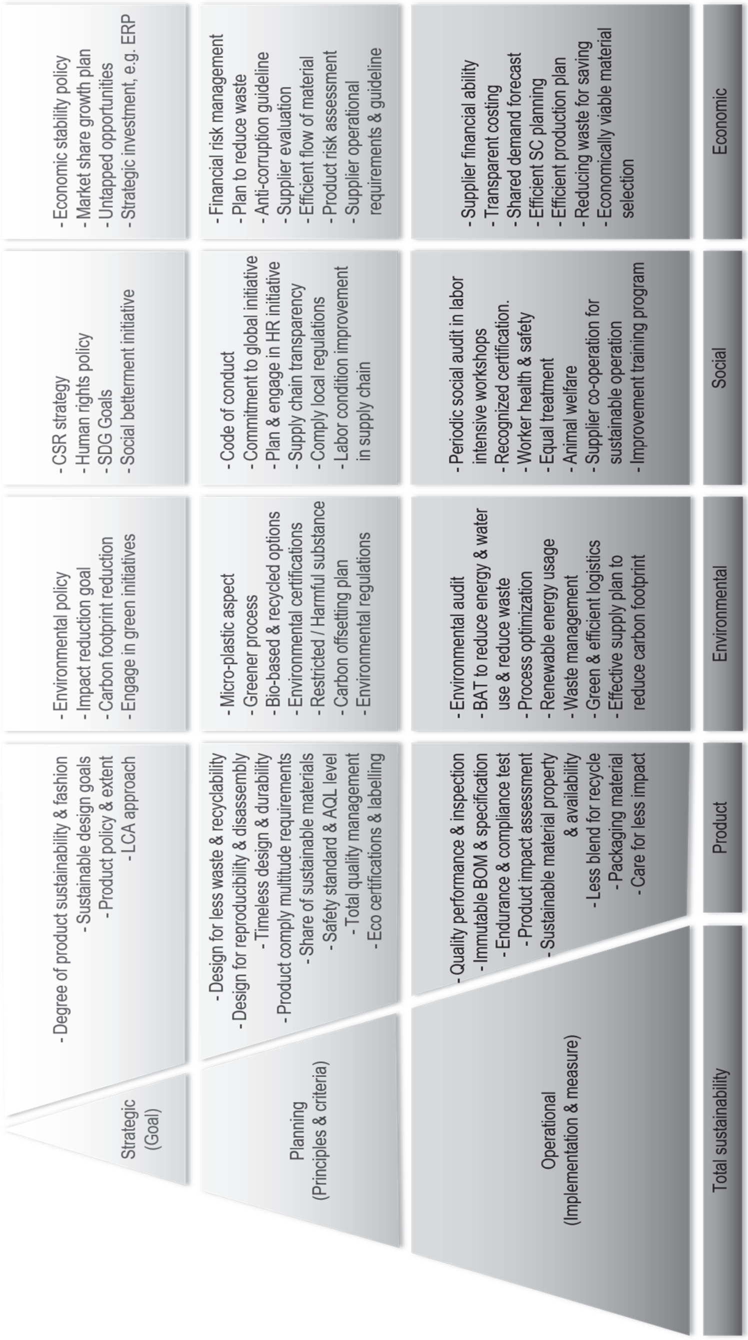

Fig. 9. Total sustainability hierarchy.

5.2 Organization of demand and supply in FSC

A general demand–supply organization in the fashion product value chain is presented in Figure 10. The functions highlighted in the model in connection with the SSCO are elaborated through Table 19. The entire chain consists of several layers, namely the market or commerce where the merchandise is sold, the brand or retailer organization, the apparel or finished product supplier in tier-I of the focal firm, material processors in tier-II, and yarn or component manufacturers in tier-III. In this study, neither the consumers downstream nor the suppliers beyond tier-III (e.g. fibre source, cultivation) are considered. Despite the segmentation in the supply-chain, this study divides the chain largely into demand and supply, based on the typical setup observed in this industry according to a commonly positioned decoupling point. The demand side in the downstream is closer to the market and creates demand through branding, marketing and sales. Often, they design the product according to the perceived needs of the market. The demand side is considered to produce intangible values, while the supply side is involved in tangible operations to produce the merchandise. As a result of globalization, organizations have lost their grip and expertise on manufacturing. The supply side in the upstream has achieved the competitive advantage of having know-how on manufacturing and the latest technologies, through which they serve the market with the perceived need and with the requirements for innovative features.

The framework also divides the associative and operative activities vertically. Associative-level activities are intended to facilitate operational activities. In the upper level, innovations related to products and materials are produced from the technical point of view. The market needs and input from the trend analysis are taken into consideration at this stage. Innovations related to materials and components, or features from tiers-II and -III, are also a critical input in this phase. The R&D of the focal company picks up the related technologies and innovations to include them in the designs for additional features.

Design receives the innovative ideas from R&D and market demand from sales, and together with the creative ideas and input from fairs, produces designs by accommodating the ideas in a commercial manner. Product management produces the prototypes with merchandising of supplier side and creates a BOM. Product compliance and regulatory function checks for regulatory requirements to be considered in product design and for manufacturing.

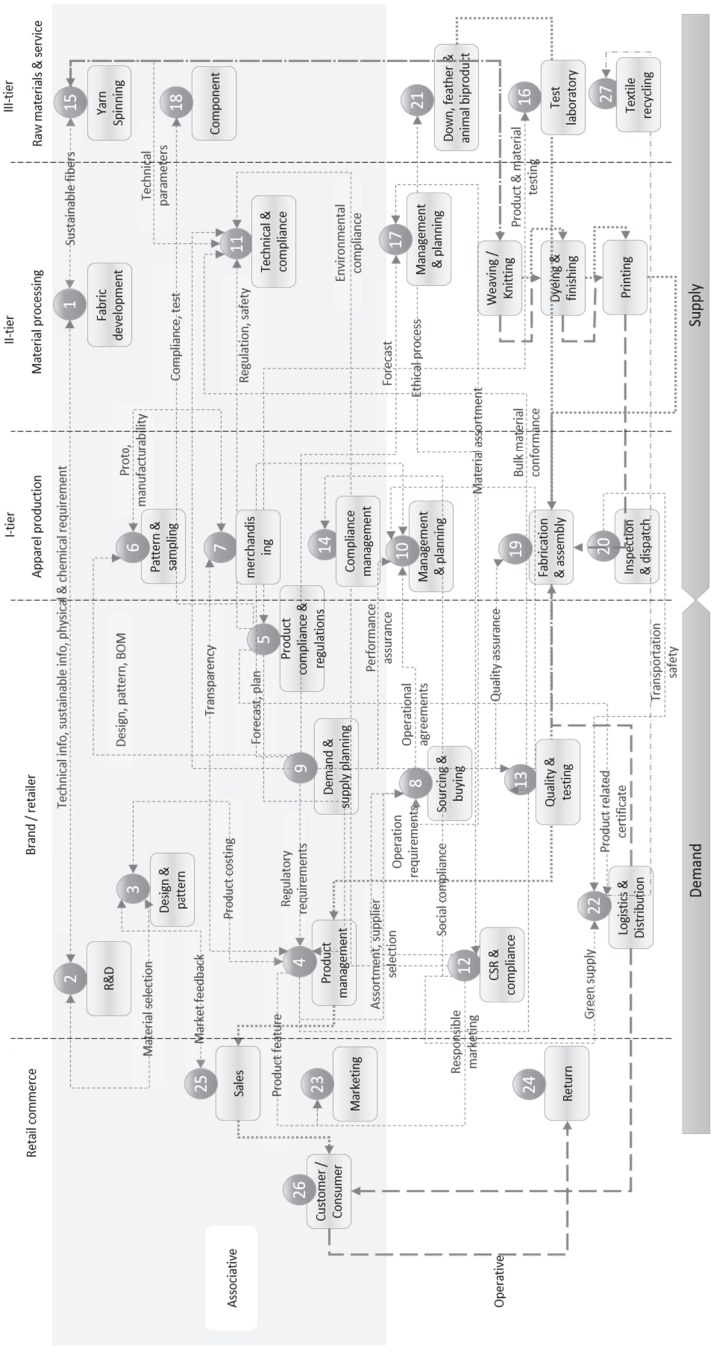

Fig. 10. Common functions in demand-supply chain.

Product management fulfils the important function of transferring information to operative functions. They provide the product costing and requirements to sourcing, which allocates the right supplier fit for the need. Not all apparel suppliers are capable of working with all different product types, but they have product-specific expertise. The CSR and compliance function of the focal firm investigate the social and environmental compliance in the supply chain in order to ensure that the products are produced in a compliant environment. The direct supplier in tier-I receive the demand and supply plan and accordingly converts it into a production plan. The quality assurance of the retail firm organizes quality inspection based on the production plan. A more accurate plan is required by logistics to organize shipment and distribution. Logistics also handles returns from customers if the retailer collects the returned goods as a part of a circular approach or returns for faulty items.

Table 19. Function descriptions.

Node	Function	Supply-chain Position	Function description
1	Fabric development	Material processing	New material development by fabric supplier.
2	R&D	Brand/Retailer	Facilitate with new innovation in material and products, provide technical guidance for product development based on laboratory test data.
3	Design & pattern	Brand/Retailer	Product design according to brand vision, current trend and feed from R&D. Product construction considering fitting related technical aspects.
4	Product management	Brand/Retailer	Product BOM creation, facilitation of different product related aspects (e.g. care label regulation) and manufacturability, co-ordinate from prototype to production.
5	Product compliance & regulations	Brand/Retailer	Follow-up different country regulations, product related requirements. Ensure product safety through different standards.
6	Pattern & sampling	Apparel production	Adjust given pattern and perform grading, develop prototype and other samples, feedback on manufacturability.
7	Merchandising	Apparel production	Principle contact point between buyer and production, Co-ordinate & organize related activities in order to fulfill customer requirement and maintain lead-time.
8	Sourcing & buying	Brand/Retailer	Sourcing plan and mange suppliers, search new suppliers, manage material flow, ensure operational performance. Buying handles the operational purchase.

Node	Function	Supply-chain Position	Function description
9	Demand & supply planning	Brand/Retailer	Demand planner produce the demand plan based on assortment and quantity requirement from sales and supply planner accommodate the customers' need through supply planning.
10	Management & planning	Apparel production	Apparel production management, scheduling & planning for customer requirement fulfillment, facilitate the non-financial requirements.
11	Technical & compliance	Material processing	Ensure technical & regulatory requirements related to product, process, chemical and environmental compliance.
12	CSR & compliance	Brand/Retailer	Produce sustainability requirements according to corporate vision, maintain CSR practice internally, provide compliance requirement to suppliers & maintain.
13	Quality & testing	Brand/Retailer	Manage internal and external tests for products, materials and components according to regulatory & quality need, provide and ensure product quality.
14	Compliance management	Apparel production	Manage social and environmental compliance according to national, international requirements and buyers' requirement.
15	Yarn spinning	Raw materials & service	Development of innovative yarn, produce yarn according to the customer need, sustainable fiber and technology on yarn processing.
16	Test laboratory	Raw materials & service	Confirms the product compliance and provide the official proof, provide guidance on regulatory needs.
17	Management & planning	Raw materials & service	Efficient production planning & management for optimum batch size, sustainable hazardous chemical free production & fulfil compliance requirement.
18	Component	Raw materials & service	Component manufacturers has a role to develop hazard free components, ensure physical requirements, compatible components for products.
19	Fabrication & assembly	Apparel production	Manufacture products according to BOM, fulfil workmanship quality requirements, fulfil lead-time requirements by keeping production output, product finishing.
20	Inspection & dispatch	Apparel production	Conduct in-hose inspection and organize third party inspection or buyer inspection according to customer need, organize temporary storing & dispatch.
21	Down, feather & animal products	Raw materials & service	Produce mainly animal bi-products by fulfilling animal rights and sustainability requirements by buyers.
22	Logistics & distribution	Brand/Retailer	Get the supply plan and organize warehousing & distribution, ensure product safety in logistics, efficient planning for sustainable distribution.

Node	Function	Supply-chain Position	Function description
23	Marketing	Retail commerce	Promote company's product and services, highlights sustainability and communicate responsible steps, organize campaigns for increase sales.
24	Return	Retail commerce	Manages product return due to flaws and organize post-consumer returns ass a part of circularity and ensure responsible processing of the returns.
25	Sales	Retail commerce	Promote sales and increase revenue, search for new sales channels and markets, grab market need to feed the company, organize customer support.
26	Customer / Consumer	Retail commerce	Business customers of the brands or retailer or direct consumer on the end of the chain.
27	Textile recycling	Raw materials & service	Sorts post-consumer textile wastes, prepare product for recycling by removing components and recycle to produce new material.

5.3 Managing demand and supply sustainably in FSC

In the FSC, the priorities on the sustainability agenda usually differ on the demand and supply sides. There can even be a regional difference in perspectives on CSR and sustainability priorities (Faisal, 2010). The requirements in the downstream do not always bear the same meaning for the supply side. Social compliance requirements by retailers are a good precedent in this regard, as a supplier must often acquire a social compliance certificate to fulfil the essential requirements for securing their business. As brands and retailers confront consumers, they often have to consider multifaceted issues, especially regarding human rights. But the reality is different in the upstream, as suppliers struggle with an immense number of activities; maintaining the expected level of welfare is difficult, as the social system of the country often does not provide much support. Acknowledging this reality, this research focuses separately on the demand and supply sides of the value stream evidenced in the case studies. Strategic-level goals do not appear in this operational model, as the focus is principally upon operational requirements. The following sections present the major operational- and planning-level considerations for both ends separately.

5.3.1 Demand-side requirements in an FSC

The requisites from the demand side result from the expectations of stakeholders and from the organization's sustainability commitment. Typical retail companies in fashion industry are deeply product oriented, hence requirements regarding sustainability and other issues are closely connected to products. The degree of sustainability requirements related to a product guides the supply-chain in the selection of different manufacturing processes and raw materials to be sourced; for example, some printers print on polyamide while others use polyester. Typically, R&D in cooperation with design comes up with the new idea. In order to proceed to realize the idea, it is often shared with the material and component suppliers, usually through the front-end business operations lacking profound technical expertise. Both the technical requirements and greener alternatives need technical soundness to be developed and applied. It is also necessary to consider the need for additional technology and processes for the new feature, as it might not be available within the existing setup. The investments are usually made on the supply side, and hence retailers must depend on them with a forecast for future business scope.

Whether or not a brand is fashion sensitive, generating new ideas and converting them into products by keeping up to date with fashion trends are the most important tasks of designers. As creativity is the core, the products' aesthetic qualities are varied by different colours, prints, and other embellishments. Product fitting is another major consideration for comfort and appearance. The product management and quality control procedure ensure reproducibility in bulk production. Every detailing in a product costs something, so transparency in costing is one of the key aspects of product management for allowing organizations to realistically include the required features in the product. The product team also share the assortments, detailing, and instructions for bulk production. They are involved from the prototype stage up to the bulk production stage, because of their superior knowledge of the product; they also manage the approval process at various stages. They also need assistance from product compliance and regulation management function for different country-specific requirements on product labelling and care instructions, as well as product-specific safety regulations. Physical safety regulations are different in different countries and regions, and there is variance in test methods and standards. The regulations also differ significantly for products of different ages and intended uses. If brands are using ecolabels or certificates, the labelling and communication of the product should also be acknowledged here. The product safety department also fulfils the chemical safety-

related requirements, often through RSL. The requirements for testing on chemical safety and performance on chemical finishes are also guided here.

This industry highly values agility as a success factor, and hence an agile manufacturing approach is one of the main requirements from retailers. Retailers share the forecast with the suppliers in tier-I as a part of common practice and prefer to reserve production capacity in advance. However, the detail assortment and colour mix, prints and other embellishment come at a later stage, close to the sales season. Sourcing and buying demand greater flexibility from the suppliers, as sales also strives for the right product mix and holdup the decision as late as possible. The industry is also greatly suppressed by cost reduction and lead-time improvement. One of the main goals of sourcing is to source products at competitive prices and reduce lead-time. The other operational requirements and conditions remain the same whether variables change or not. Retailers share the different requirements and norms through a formal document signed about the operational procedures. Requisites on social and environmental compliance, as well as other CSR-related issues, are communicated in the same way. Retailers' own audit program or other long-term commitments (e.g. an SDG implementation program) are shared with the suppliers where co-implementation is required. Other sustainability-related programs (e.g. carbon footprint reduction) are also greatly dependent on support from the supply side, as well as proper planning from the demand side and consideration in design. An efficient distribution plan and production at a reasonably early stage to reduce expedition (e.g. air shipment) has a great influence on the emission reduction. Proper and unambiguous information and documentation also plays a role in on-time delivery and customs clearance.

Product sustainability is the most important consideration and is an area where retailers need direct control in order to comply with the many different regulations and requirements related to product safety and ecolabelling. This requires greater know-how regarding technical aspects and different regulations. Quality assurance is also associated with producing compliant products, which is ensured through quality guidance and requirement – for example, AQL. A stricter AQL has an influence on production efficiency and cost. Failure in product compliance is not only related to product sustainability, but a direct influence on economic sustainability. Product failure-related recall could cause severe harm to the organization's reputation and economic performance. However, maintaining different kinds of physical and chemical tests and certifications is costly, and an efficient plan for compliance tests is therefore key.

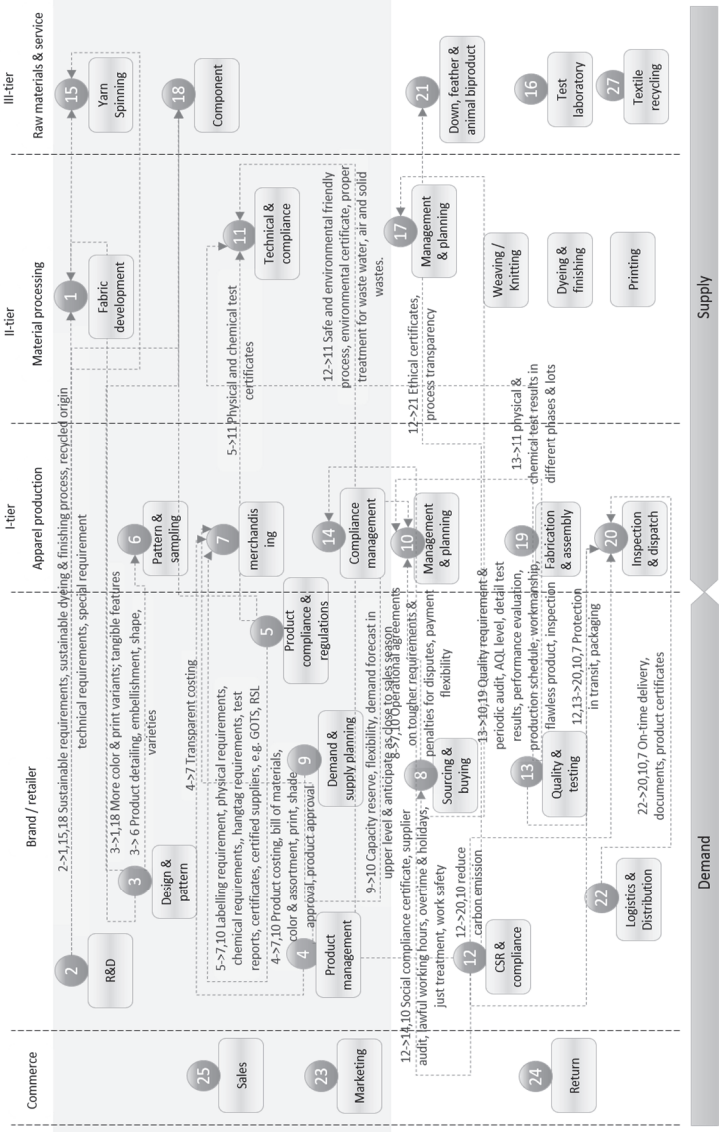

Fig. 11. Demand side requirements in FSC.

In order to maintain supplier performance stability and produce products according to requirements, brand companies also conduct quality reviews and performance evaluations for their suppliers.
A sustainable product must also be produced ethically. Although typical social compliance issues are ensured through certifications and auditing, animal rights are also an issue that retailers are often urged to ensure in their supply-chain, as animal-origin materials are commonly used in textile products. Wool is one such example, where retailers at least need to ensure that animals were treated humanely, and suppliers ensure fair treatment through certificates (e.g. mulesing-free certificates). Some companies ensure greater visibility in the supply-chain of animal product sources, while some depend on certificates like the 'Responsible Down Standard'. Such ethical certification can be communicated with the consumer through product hangtags.

5.3.2 Supply-side challenges in a fashion supply chain

The theoretical overview revealed challenges specific to upstream which were also investigated in the case studies. Manufacturing companies are confronted with practical challenges related to implementation of sustainability requirements more than downstream firms. The supply side must fulfil the downstream requirements with a practical approach. Moreover, they have local legislative requirements and societal demands to contend with. Maintaining different kinds of sustainability requirements is cost intensive and expertise is required from the top management and at the operational level. Furthermore, different customers have different requirements and procedures, which has an impact on operations. Accommodating different requirements from different customers in their own management approach (e.g. lean) is not that straightforward, especially if it is a non-standard request. Different product types also have an influence on production arrangement and line setup, particularly in the labour-intensive activities in tier-I. The impact also extends to tier-II and beyond, for example in material manufacturing where even the equipment setup might differ from the usual arrangement.

In general, retailers deal with the tier-I suppliers who prepare and deliver the final products. New product features or technical requirements on materials and components are also communicated through them. Often, direct suppliers receive several requirements which are not necessarily directly related to them, but they have to accept the liability as a final product maker and stretch the need to the upstream. For high-quality products and compliance with legislative requirements,

it is critical that the materials are produced according to the norms. The new requirements from R&D often need deeper technical understanding and consequence on final product properties and compliance. The process of development of effect and properties on materials through tier-I suppliers is inefficient and burdensome for the apparel manufacturers. As an intermediary in the process, apparel producer communicates the buyer's requirements to material suppliers as they are dependent on material suppliers for fulfilling the requirements of the final product. If not vertically integrated, suppliers also explore different options to acquire materials with the required properties at competitive prices. Such a setup is also an obstacle for knowing about different development possibilities from the material suppliers. Applying new technology may require investment in manufacturing, and companies in the upstream usually takes the risk. The logical increase in product cost is not easy to achieve, as the marginal space on product costing does not allow for additional costs.

As manufacturing costs are constantly on the rise, it is important to achieve production efficiency to reduce costs, and lean method is one of the prominent ways to achieve that goal through reduction of waste in production. But the recent trend of having the products in commerce with very short lead-time and in quick succession is not complementary to the lean approach. Moreover, excessive varieties and smaller volume reduces the extent of high-volume production drastically. In order to reduce waste and achieve greater efficiency, an apparel production setup requires some minimum quantity, as efficiency increases gradually over time. Similarly, in material manufacturing, whether a batch or continuous process, there is a certain load requirement, and below the optimum load level, it is not possible to achieve economically feasible production, and product quality may be affected. An efficient plan is important to accompany all the similar styles, even from different customers, to achieve production efficiency. The changeover time improvement can help reduce the cost. Non-standard embellishment works, or any other steps, reduce efficiency; hence it is important to explain this to the designers. Such feedback may reduce the gap in knowledge on manufacturability and can benefit both parties where concurrent development is beneficiary. For economically sustainable business operation, it is important to achieve mutual benefit for both. All these challenges related to manufacturing should be addressed in the product development stage. At the same time, non-competent processes and products can have a serious impact on the final product quality, which may lead to a non-quality or even non-compliant product.

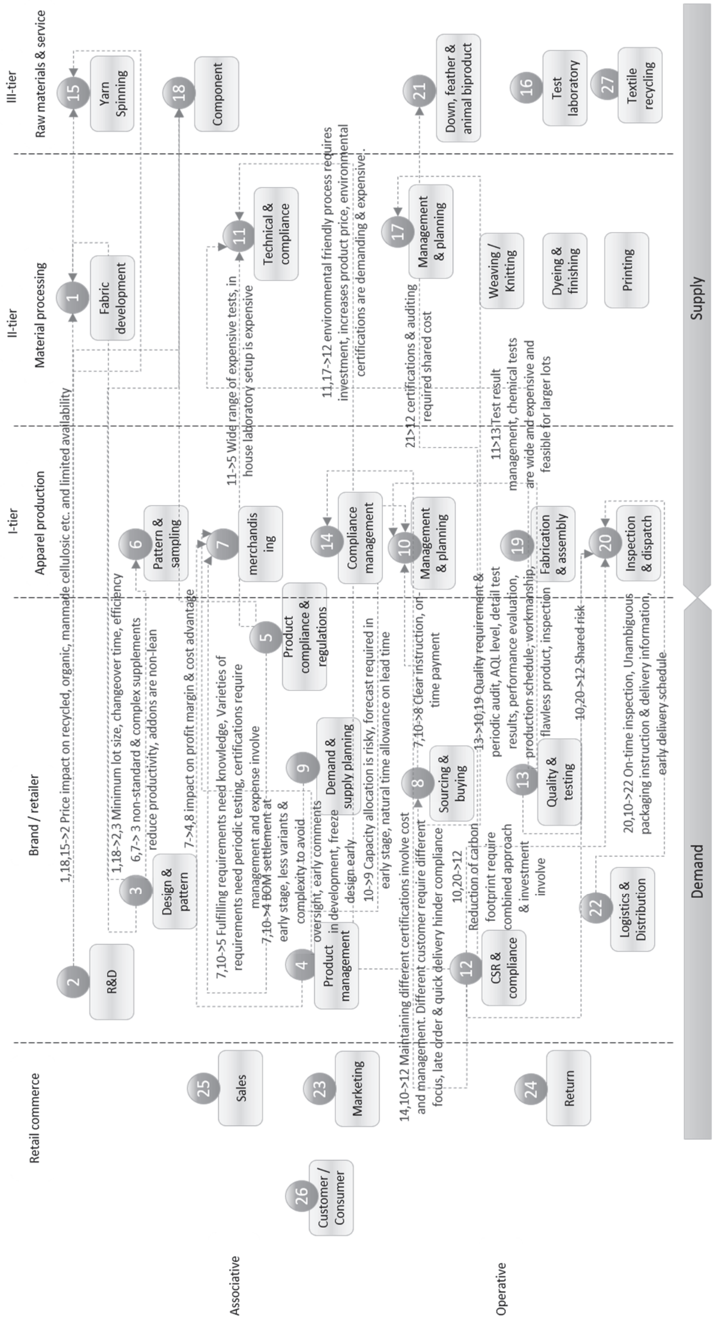

Fig. 12. Supply side challenges in FSC.

With the growth of stringency in product compliance, closer attention must be paid to production. Often, manufacturers must accept liability for product failure, especially due to manufacturing-related faults. The increase in the extent of product recall puts the brands and moreover the suppliers in a vulnerable position. It has a direct influence on economic sustainability. Although apparel manufacturers generally understand the physical safety requirements, it might not be as easy to comprehend the comprehensive chemical requirements. It is worth mentioning that oftentimes, failure of chemical requirements is not possible to adjust or correct. Brand reputation suffers in recall cases, but loss of sales could be reimbursed by claiming to the suppliers. In addition, significant costs are involved in terms of penalties and managing recall operations. The process of conducting different kinds of physical, chemical and other tests for products, materials and components is expensive, especially for the small lots where tests are required for each different colour, for different finishing, or even for each lot, and it is not uncommon to disregard it in product costing.

One of the challenges faced by apparel manufacturers is obtaining unambiguous and consistent information, unchangeable BOM, comments on prototypes for further change, and a final revised version of the prototype on time. A change in product information creates an interruption in operational flow and increase the risk of flaws. Concrete information on product varieties and detailing should also be shared early enough, as some specific components' lead-time could even take several months, depending on the design and transportation time, which could be considerable depending on the location. Transparent information at all stages is critical on the supply side, as in practice they prepare for production and reserve the capacity based on the information only. Supply schedule, documentation, and other requirements are also important not only for avoiding mistakes but also for receiving payment smoothly. Long-term commitment and a risk-sharing approach build a healthy relationship between the parties, which is ultimately beneficial for both. The mutual relationship is also important to improving intangible requirements. Providing quality requirements or defining the AQL, as in ISO 2859-1. is not sufficient in itself to produce good-quality products. Stricter AQL requires more follow-up in the production – stricter in-line quality inspection procedures – which has an impact on production efficiency. Furthermore, failure to meet the requirement results in reworking of the products, which significantly affects efficiency and production cost. Nevertheless, product quality is one of the most important considerations on the supply side, as it is the most significant competence allowing companies to stay in a business. Once a company

is able to deliver quality products, other supply-chain key factors (e.g. CSR practice) can be improved.

Customer requirements for social and environmental sustainability need a comprehensive approach. Besides acquiring social compliance or other certifications, knowledge of sustainability and proper management of compliance issues enables companies to maintain a competitive position. Often, different customers have different certification requirements. In addition, brands' own audit programs or different CSR activities are also conducted through the suppliers, especially programs related to working condition improvement. CSR is an area of increasing attention, although still it is regarded as a criterion for competitive advantage.

5.4 Key considerations for SSCO

The earlier section demonstrated the requirements of FSC in downstream and its challenges in upstream. In order to focus the key activities for SSCO, this research endeavours to address the priorities of both the demand and supply sides. The framework (see Figure 12) aims to facilitate activities in a sustainable way throughout the demand–supply chain. The qualitative model is manufactured from the strategic aspects of the sustainability hierarchy. The key activities depicted are mainly from the planning and operational levels, incorporated to facilitate sustainable operations. The planning-level elements are seen more on the demand side, while operational activities are observed on the supply side. As a matter of fact, whether on the demand or supply side and whether a company emphasizes sustainability or not, they have to incorporate sustainability in due course to sustain the business. The flow of activities is ruled by product-specific needs and sustainability considerations. This is also an important approach for circular economy, as the product is the main element in achieving circularity. A product should be durable enough to be reused, and at the end of the cycle it should be recyclable. The key considerations for SSCO presented below.

Product and material features in supply-chain organization

Like other industry, products centricity is also a feature of the textile-apparel industry, as the priorities for sustainable operations are guided by the type of product, fashion sensitivity, geographical location of manufacturing, and business ideology (e.g. FF). The challenge and focus are different for different setups. If the

product is made of cotton or another natural fibre, the supply-chain has a different setup compared to that for a synthetic material-based product. Even the source of raw material and process of manufacturing fibre is entirely different for these two different types. Therefore, the focus on sustainability criteria is different too. While the natural fibre supply-chain embraces social sustainability challenges, the synthetic fibre chain focuses on environmental sustainability for their natural dependency on non-renewable resources. Different sustainability aspects are intrinsic elements in creating sustainable products. A product is ultimately sustainable if it produces lower environmental impact during life-cycle and is produced ethically in all stages.

The role of R&D

The role of R&D is to set the path for sustainable life-cycle of the product. This study asserts that core development activities should be set out through R&D which considers sustainability and circularity as an integral component and which is aligned to the sustainability vision of the focal firm. The material of a typical piece of apparel is the biggest part among all components used to make it and absorbs most of the product cost. The technological involvement is probably highest and environmental impact also believed to be the most. Therefore, the R&D has a greater role and they should work closely with material development to achieve the required properties in the most sustainable and commercially viable way. Innovation in yarns and better alternatives is also found through material producers. The co-development approach will consider possible challenges for reproducibility in production. It has a significant impact on the final product quality, and material quality assurance reduces the majority of the quality risk of the final product. Making a quality product is not possible with substandard materials and components. The required functional properties of materials and components should be communicated at a technical level rather than placed as buying criteria. A proper balance of price and performance can be established at the development stage. Material composition and construction should be fixed according to the final product requirements; for example, if a product will be used for children's sleepwear, the fibre should be selected so that it achieves flammability requirements. Simultaneously, the regulatory requirements for different markets (e.g. CPSIA) should also be considered for making compliant products. The restriction of the usage of harmful substances should also be addressed at this stage, as RSL are often extensive and require technical expertise on process and chemicals.

The different requirements set the process to be used and also influence the price. For example, if a PFC-free process is required for a performance material, the material price will be different and separate equipment must be used to avoid PFC contamination. At the material development and choice stage, it is also important to consider material or product certification as a part of making a viable product. If a material is from a greener source – i.e. recycled or organic – this must be proven through certification for credibility. According to Na and Na (2015), with fabrics that are certified for the use of organic and green material, the producers must also be certified in order to produce a certified product (e.g. Oeko-Tex certified product).

Design with operational focus

Designers collect inspiration from different sources, but they also receive internal input, mainly from sales. Research and development translate design ideas into an applicable format and develops the technical specification. With the help of apt tests and review regulatory criteria, R&D facilitates design with the selection of compatible materials and components. The selection of raw materials is a critical phase, as innovative technologies such as waterless dyeing, non-toxic dyes, digital printing, and nanotechnology-based coatings can play an extensive role in reducing the eventual impact on the consumer phase; for example, the reduction of the need for domestic laundering (Kozlowski et al., 2012). Because of their in-depth expertise, the impact on the environment by different kinds of fibres and materials is also checked, which helps to choose the sustainable option. Neglecting R&D in product development poses the risk of disqualification. Company-strategic goals together with designer choices can have a great impact on the sustainability of the final clothing product, and at the design stage, the cost of intervention is comparatively low (Clancy et al., 2015). Technical properties and information are important input for the BOM for product management and also for communication.

Product management for transparent flow of information

Product experts evaluate the design from a manufacturability and cost perspective. The role of product management is critical, as they are the bridge between the brand and merchandising from direct suppliers. Through merchandising, they produce prototypes with pattern and sampling organization and provide comments on prototypes in order produce the final sample, typically salesman samples. It is critical that an immutable BOM be created once the final prototype is accepted.

Vague or incorrect information hinders agility in the process and poses a greater risk for flaws in production which could ultimately cause product failure. The sampling section of the apparel firms needs empowerment and a concurrent approach with production in order to provide guidance for smooth production. Complications in product styling must be shared with production as well as merchandising to address in costing. A transparent costing is recommendable for proper understanding of the processes and corresponding expenses. For superior communication of the actual product features with the consumers, the product team should provide unambiguous information on ergonomic characteristics and naturally on the technical features. The information is important to increasing the product's desirability for consumers, which impacts on sales.

Product compliance assessment for risk reduction

Product compliance and regulation must be considered carefully, especially during the prototype development phase. For example, the care label requirements are highly specific in some countries, which must be considered in the development phase. It might even require adjustments in design. For example, China requires the care label for baby items to be placed outside of the garment. The compliance verification is also significant for the risk posed to instant impact (e.g. drawstrings or cords in children's products). They guide the product development according to the different needs for different ages, different use purposes, and different risks. The product compliance unit also guides the suppliers through the necessary product-related tests. It is not uncommon that retailers also conduct some laboratory tests either by themselves or through a third-party laboratory, especially those having an impact on aesthetic values (e.g. pilling, colour fastness). They also provide the requirements concerning chemical safety and regulatory requirements to the tier-II suppliers. Moreover, if there is a specific safety certification requirement (e.g. Oeko-Tex or bluesign), this should be addressed in advance as the supplier might require special arrangements or certification before fulfilling requirements. Components may need different kinds of tests, and test optimization can be achieved by sharing the test reports. There are many different aspects of product sustainability, which not only considers sustainable or green solutions but also embraces different aspects of physical and chemical compliance. To preserve brand image and safeguard economic stability, a company must consider the product sustainability as a core aspect of sustainability, whether or not they take a true sustainability approach. Many different environmental compliance issues are

attached to the product, which have been addressed in the discussion and propositions in this chapter.

Sustainability-driven SCO

The product has a great influence on social compliance and human or animal rights. During product development, it must be decided whether raw materials from animal sources will be used. If they are used, it is their duty to ensure that the animal by-products are sourced ethically and that animals were treated humanely. At a minimum, the supplier must prove this with some certification, and this should be part of the product cost. The sourcing function of the focal company plays an important role in finding partners with the same ideology and operating in a responsible way. Besides commercial terms and conditions, it is essential to check for product quality performance and social compliance. They often work together with the CSR and compliance sections in order to investigate sustainable performance. In general, the CSR function provides the baseline requirements to sourcing as primary criteria for selecting a supplier. A similar prerequisite is also provided for product quality. A pre-audit on quality management reduces the risk of general quality failure (e.g. workmanship). The pre-audit is critical for building a long-term relationship between buyer and supplier. Social compliance certification systems (e.g. BSCI, SA800. WRAP) are a commonly used method for proving social compliance performance. Albeit, it provides a minimum confidence on the supplier's social integrity, but it is important that the brand have the visibility of the supply base through their own compliance management program. One important consideration is that maintaining social compliance is the responsibility of both parties, where each should take a participatory approach to maintenance and shared expenses.

Sustainable sourcing and buying

Typically, sourcing and buying focus on efficient and cost-effective purchasing of their product, but for sustainable operation, it is important that costs appear as direct rather than hidden costs. In operational agreement between the parties, all commercial and sustainability terms should be considered for sustainable operations. The traditional way of placing orders and acquiring goods are unfit for sustainable operation and it must be realized that sustainable products is not about using some sustainable feature (e.g. recycled polyester or organic cotton) in the

product, but about how and in what conditions the product is produced. The cooperative approach is very important to producing a win-win situation. It is important that the challenges on the supply side are considered and that the demand side facilitates the necessary information. The retailer's demand and supply planning should be shared as forecast early enough for the proper planning to level the demand from the supply side. One efficient way to accomplish this is to book the material in greige level. Clever selection of material composition is one efficient way to reduce varieties, and variety in colour, effect, prints, and even finishing process is a good method of differentiation. All the varieties at material and component level should be shared in good time, as the material manufacturing process is extensive and unforeseen challenges are common. Disruption in manufacturing has a direct impact on quality. The material inspection process is a meaningful way to reduce quality problems at the source. It is important that sourcing and supplier agree on some common procedure (e.g. a four-point system) and decide on the portion to be inspected. Materials and components must be purchased from the nominated supplier, otherwise it is challenging to control quality and regulatory requirements, especially related to chemicals. Tier-I suppliers should also be involved in the process and must receive the assortment and plan early enough. The forecast should be provided for a long-term and real plan early enough. As apparel manufacturing is still mostly handwork and labour intensive, it is important that manufacturing be given enough time. Any additional rush in production increases the risk of fault. Agility at a late stage often forces the suppliers to work with non-standard arrangements, requiring overtime work and a noncompliant method of meeting the schedule. Workers are the ultimate victims of such arrangements, and social compliance is at risk.

Quality assurance for compliance

Suppliers must provide the production schedule early enough that the quality inspection can be organized. The inline inspection is a better way to reduce flaws during production, and final inspection ensures that products meet the required quality level. Quality inspection strictness should be agreed through operational agreement, as it impacts production efficiency. If a stricter AQL is agreed, it should be reflected in the product price, as it may push for additional control steps and even reworking of the merchandise. Before the cutting and stitching, the bulk material should be tested mainly for physical properties, as cut or finished material could be unacceptable to the material supplier when claimed for fabric faults. Also,

it produces a lot of waste, as the final product is not up to the mark and will not be sold or used. The product tests to be performed from the first pieces from production to the passed test result are one checkpoint for the dispatch of goods. Various test methods, standards, and requirements for appearance and performance specifications of fabrics and garments have been developed by different organizations such as AATCC, ASTM, and ISO (Farashahi et al., 2018). On-time test results and documentation reduce the risk of unnecessary delay. Some customers might need product specific certification or transaction certificates – for example, GOTS (the Global Organic Textile Standard). It is also important to handle the finished product properly, as these are often in transit for long periods. Sometimes, there is considerable variations in temperature and humidity during transit. Therefore, proper conditioning of goods before packaging and proper protection are a must. Mould-proof packaging is used to protect valuable products, as mouldy products are not only impossible to sell, but also impractical to repair, and often non-replenishable due to time constraints which cause lost sales. Total sustainability also requires the lowest possible carbon footprint in transportation, which can be obtained by efficient transportation with a good supply-chain setup. If the production is possible to execute as scheduled and with no expedition required, products can be shipped in the greenest way – for example, by ship, which is slow but nevertheless the greenest available method of transportation.

Many factors influence sustainable methods of demand–supply management, and the different propositions provided within the framework from the practical point of view. The challenges observed in Case studies are taken into consideration, and the propositions have considered the views of both sides. All the activities depicted in the framework are directly and indirectly related to the product, and all are linked to sustainable operation. The model also incorporates product traceability, an emerging issue in this industry, as well as considering the LCA approach to minimizing the impact of each operation.

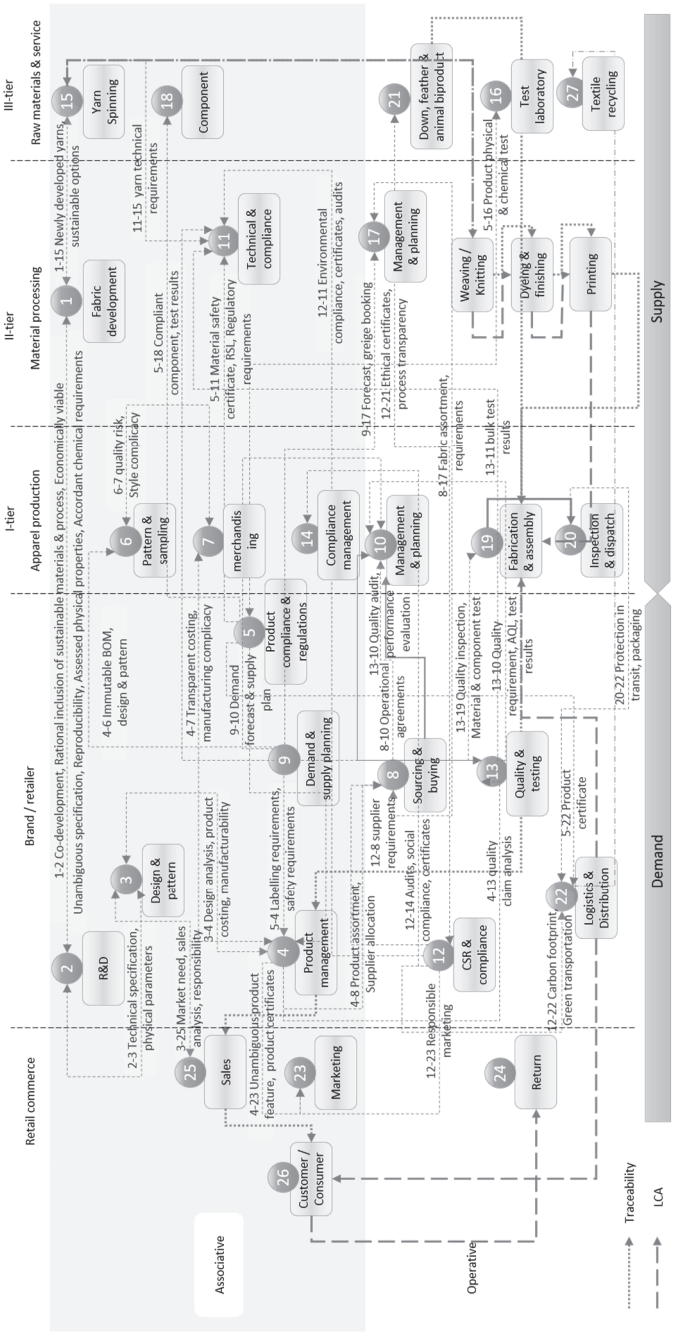

Fig. 13. Key considerations for SSCO.

5.5 Value creation through substantive approach

The previous section presented the key activities and considerations for the substantive approach to sustainable operation. This section highlights several important aspects from the framework which have direct impact on the value creation process (see Figure 14). The highlights consider the benefits on both the demand and supply sides, which have a direct relationship with sustainable operation.

Sustainability begins with R&D

As emphasized earlier, all sustainability aspects should be considered at the beginning in the R&D and design phase. The initial phase of product development is material and component selection, which requires technical expertise. A database could be created on the typically used materials and their impact throughout the lifecycle. The source of raw materials is a good consideration to reduce impact. Where possible, material from a single fibre should be preferred, as mixed-fibre material has a greater impact on footprint and requires more processing steps. According to the proposition in this model, material development should involve achieving consensus on sustainable and technical issues. The focal company's R&D should select the least possible number of base materials, which means less variety in composition and construction. Furthermore, the number of colours and prints also should be kept in optimum label. It does not intend to limit the independence of the design but produce varieties in an efficient manner. The varieties can be produced through coating, lamination, and various other finishing at the fabric stage. The number of different patterns should also remain limited, and different styles can be produced by changing the colour, detailing, and various components. Use of piece print, reflective details, embroidery, and other elements are also good means of differentiation, which could significantly change the product's appearance without majorly altering its components. It is an efficient way to make the labour-intensive part lean and simultaneously to add fashionable or additional features to the product.

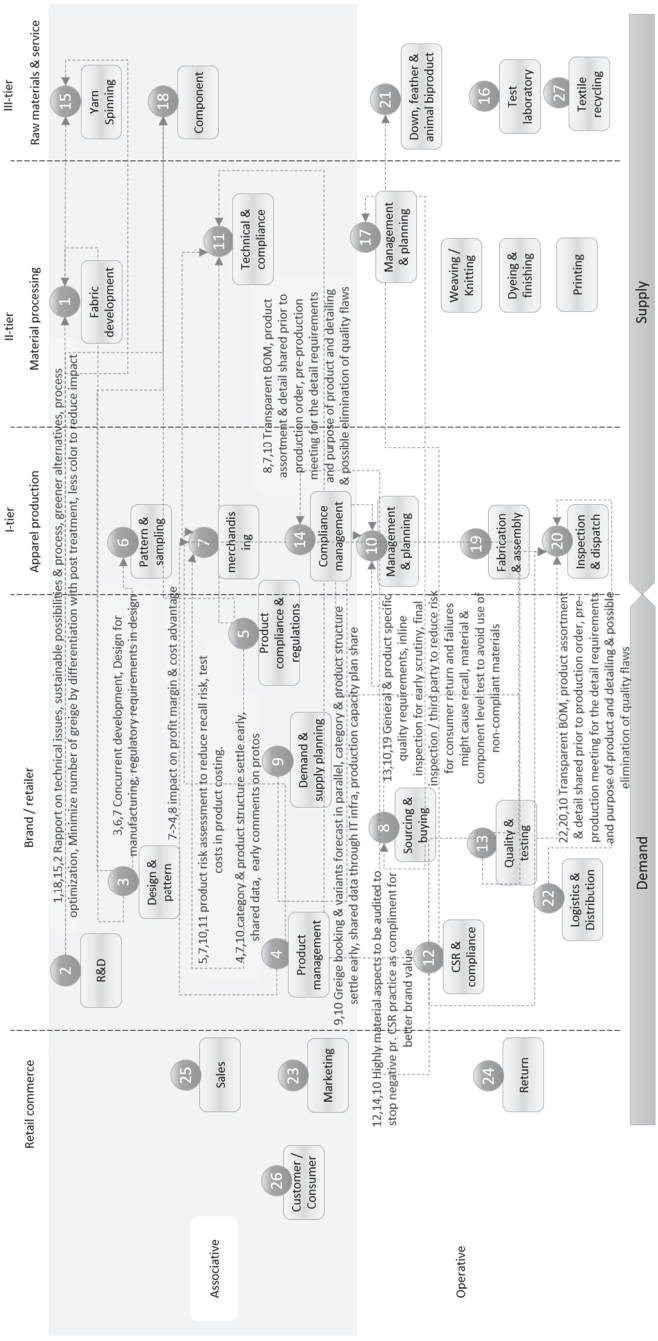

Fig. 14. Value creation through substantive approach.

Assessment for manufacturability and failure

In the prototype development stage, designers and pattern makers consider the manufacturability of the product by soliciting feedback from the tier-I supplier. The product team provides the design requirements and detailing of the products and organizes the prototype development activities. It collects feedback on styling and possible challenges in production. Overly complex styling could pose a risk for quality failure and ultimately might not meet some regulatory requirements. For example, ornamentation with crystals in children's apparel might pose a risk with small parts, according to 16 CFR 1501 of CPSIA. The physical safety issues and different market specific requirements (e.g. care label) are verified through product compliance. In the prototype stage, various tests should be conducted for safety, especially tests related to design (e.g. sharp edges, small parts, drawstrings, flammability). The concurrent development of products in a production line is a practical approach to observing the possible challenges from a manufacturability, quality, and product compliance point of view. The merchandising of the supplying company considers all the different costs and includes them in the product pricing through transparent costing. This approach provides a perspective on unknown costings related to the product and simultaneously gives the supplier the opportunity to assert hidden costs (e.g. costs related to different in-house or third-party tests). Co-development and transparent costing in both material and prototype development opens up the possibility of adjusting the parameters according to cost. If some properties in standard material shared from material suppliers are of high values (e.g. very good abrasion resistance), they could be adjusted according to the product purpose and target cost. Every functional property requires additional treatment which costs something in production.

Selection of supply-chain partners according to competence

In the supply-chain, different factories might have different setups and capabilities for different types of products. It is critical that the partners are also selected according to product type and capability of meeting certain quality standards. Although the product itself might not be a difficult one, when it is necessary to produce it in bulk quantities, both efficiency and product quality may fall short of expectations. To produce per expectations, it is important to consider capabilities derived from habit, which ultimately delivers efficiency and quality. The experience also helps in detecting possible challenges at early stage. Product risk

assessment helps to identify potential failure possibilities, and actions can be taken for the risks of recall, which causes financial risk for both parties. At this stage, different certification requirements related to the product are also verified – for example, registration for a product treated with biocides. Although suppliers are chosen based on the focal company's certification requirement (e.g. bluesign, Oeko-Tex, GOTS), they should be verified according to product requirements and validity of certifications. Although there is a clear increase in price for achieving products certified within some sustainability certification program, it provides the license to communicate with consumers about sustainable production and safety. Certification programs which work in tier-II and beyond are an easier way of ensuring chemical safety where the retailer's visibility is insufficient.

Efficient product data management for immutability

From the retailer side, the product category structure should be set early enough for a specific sales season and should be invariable. Product development should have to fix the BOM after all necessary prototype stages. The BOM should be shared with suppliers early enough and possibly through a shared IT platform in order to check the possibility of sourcing materials and components. Some components might need much longer lead-time than traditional. If the product contains some uncommon raw material, the possibility of sourcing them in bulk and the minimum order quantity is a greater consideration. Some components might even need to be tested in a real environment, which should be done well in advance of the sales season. The product category structure should also be shared with the sourcing function which should allocate the right suppliers among the supplier pool, considering the commercial point of view. According to the forecast, material greige booking should be made to omit them from lead-time calculations. The demand and supply plan should be aligned with the production capacity of the suppliers. The aligned plan should fulfil the need of level scheduling, which is complementary to producing quality products.

Comprehensive quality assurance throughout

Quality assurance and control is significant on both the retailer and supplier sides. Before production, all the material test results should be verified, followed by a pre-production meeting to check all the comments on the prototype development stage, special considerations, product purpose, safety issues, and of course quality

aspects. While the pre-production session ensures the information transfer, an inline inspection is an essential part of reducing the production of faulty products. There are often hidden parts in the apparel whose quality and workmanship can be only ensured through inline inspection. A final inspection is a very common procedure for checking product conformity according to the agreement. In this phase, all the test results and certifications should be verified before shipment to ensure that product flaws are not exposed in commerce. It is an important step to safeguard against product recall, which entails significant risks for a firm's economic sustainability.

The focal firm's role as sustainability leader

Often acting as the facilitator in the supply-chain, the focal company should design the supply-chain for the easy transfer of products from the supplier to commerce. A logistics plan should be formulated for the shortest possible route and transportation method for the lowest possible impact on the environment. Hence, it is very important that one shares the supply plan early enough to avoid any kind of expedition. Late changes in the supply plan also produce uncertainty in the supply, which could result in penalties for late delivery. For the substantive approach to social and environmental sustainability, it should be participatory rather than being imposed as a requirement. The retailers should align their social and environmental requirements with local standards where possible, making it easier for both parties. The focal company should commit to the specific SDGs which correspond to their operations and where they have more possibility to make an impact. Ideally, they must also involve their suppliers in fulfilling the goal.

5.6 Validity and reliability of the study

The results of this study have built upon the extensive experience of the researcher in the field of sustainability in FSC and on profound research on this topic and SCM. The research began in 2013 and lasted until the formal compilation of the study began in 2019. The combined experience of academic research and a career in industry in both downstream and upstream of the supply-chain provided a solid foundation for this research. Furthermore, experience working in both manufacturing and retailer companies helped to formulate research questions by addressing practical challenges.

The success of this research is greatly dependent on having appropriate case companies in order to comprehend the research problems deeply from a practical perspective. As Eisenhardt (1989) states, selection of cases is an important aspect of building theories from case studies. It is also critical to achieve proper insight and information through case studies and to contact the right interviewees and information sources. In this study, personal contacts in the industry and secondary contacts through experts are regarded as assets. It is worth mentioning that the cooperative attitude of the interviewees and others in case companies and their interest in sustainability simplified the task significantly. All the data collected for this study – in the form of notes, questionnaire answers, documents, recordings, and so on – is stored safely in digital and physical form for further analysis. Additionally, the questionnaire and the forms for the pair-wise comparison from each case are retained for future reference. Validity is a process in the research whereby it is validated for the quality of solving the problem it intends to solve and for the process followed in the research approach. Gummesson (2000) states that validity means in essence that a theory, model, concept, or category describes reality with a good fit. This study followed the validation process as compiled by Yin (1994). As stated, validation consists of steps like construct validity and internal validity, in addition to reliability.

The construct validity phase test is based on data collection and composition. In this phase, validation will be performed for the case study according to the tactics used (e.g. use of multiple sources of evidence, establishing of a chain of evidence, and key information review draft report). This study has utilized diverse experts from many different companies in both upstream and downstream, as well as different countries and nationalities. The case companies are also from different product categories and from different positions of the supply-chain. For instance, there were manufacturers, a Western buyer's local buying office, retailers with outsourcing from Asia, as well as retailer with nearshore manufacturing. Although the primary focus of the empirical studies was to fetch information through interviews, other methods like case company analysis, observation, questionnaires, and company visits also took place. The interviews also revealed some new issues and different opinions which are also reflected in the analysis results. This study also made use of the triangulation methodology. According to Maxwell (2008), triangulation as a validity testing strategy reduces the risk of chance associations and of systematic biases due to a specific method, through collection of information from a diverse range of individuals and settings and using a variety of methods. The next quality measure is to establish a chain of evidence in the research process,

which is greatly fulfilled by achieving a linkage from setting the research question up to constructing the model. The study approached this with the groundwork of setting the key supply-chain performance factors which were used in analysing the priorities. Data calculation from the cases followed the AHP validation process for the calculations. The collected data from each case was carefully compiled for both qualitative and quantitative analysis.

Internal validation is principally based on data analysis, where the validation process follows tactics like pattern matching, explanation building, and time series analysis. The structured approach of the study assisted in answering the research questions in an appropriate manner. Eisenhardt (1989) found that qualitative data often provides a good understanding of the dynamics underlying relationships – the 'why' of what is happening – and that it is crucial to the establishment of internal validity. Gibbert (2008) state that from the three tactics of internal validation, the triangulation approach could enable researchers to verify findings by adopting multiple perspectives, which has closer proximity with this research. Eisenhardt (1989) found that the triangulation made possible by multiple data collection methods provide stronger substantiation of constructs. Cross-case synthesis is the approach taken in comparing the findings from the cases where data from each case was studied separately, and downstream and upstream syntheses were compared descriptively.

External validity is dependent on research design and follows the tactic of using replication logic in multiple Case studies. This is a multiple case study based research project and makes it relatively easy to conduct analysis. Gibbert (2008) emphasize in their analysis of external validity that the researcher should provide a clear rationale for the case selection and ample detail. Chapter 2.1.2 provided the detail for case selection, and Chapter 4 presented each case separately; the case description, data collection, and data analysis were presented in an easy manner followed by an analysis of the average results of all cases in upstream and downstream separately. Besides typical validations, this study also attempted to validate through focus group discussion in order to present and discuss the outcome of the conceptual model.

Seal, Bogart and Ehrhardt (1998) suggest that the focus group type methodology may help to validate study results, and this research has adopted the approach in order to validate its propositions. With the help of focus group, the industry experts on both the retail and manufacturing sides were brought to share their opinions based on their experience and perspectives. The focus group (see Table 21 of Appendix 2) was fairly compact and composed of industry experts and

a researcher developing herself in the arena of CSR. Focus group members from upstream and downstream provided their opinions based on the presented model and verified whether opinions differed and whether the model was utilizable. The research aim, approach and findings were described by the researcher to provide a clear and detailed overview in addition to the information provided earlier. After the formal presentation of the research, each individual member commented on the model and shared their own opinion. As part of the discussion process, the researcher, in a moderator role, also raised some questions, as Brannen (2005) mentions that asking questions is allowed in the focus group method. The small forum also helped in understanding the proposition quickly, because their background and opinions were remarkable for the model, although suggestions also came up. There were no major comments as such, but shared observations on cost sharing in CSR activities, suppliers' multi-customer requirements, regulatory tests, chemical requirements, and so on. The model was praised for considering the same aspects in demand and supply contexts. All the members of the focus group agreed with the pertinence and effectiveness of the model, although concerns were raised about its implementation in a small-scale organization.

According to Gummesson (2000), validity is seen as a continuous process which is integrated with theory and which requires the researcher to continuously assess his assumptions, revise his results, retest his theories and models, and reappraise the given limitations that have been set for the study. The period of the whole research was rather long, and it evolved through many phases. The research questions were the foundation to keep on track the comprehensive research work, as if it became derailed, the question would remind the researcher of the aim of the study. Gibbert (2008) describe reliability as transparency and replication, where transparency can be enhanced through measures such as careful documentation and clarification of the research procedures, and replication may be accomplished by compiling all the documents systematically. Each step of the research process is documented carefully, and all the hard copies are also compiled. A database of the related literature is also maintained aside in order to cross-check the insights collected from the cases.

6 Discussions and conclusions

The aim of this final chapter of the thesis is to summarize the research and briefly discuss how the research questions were answered. Theoretical contributions and practical implications are also assessed. The obvious limitations are also discussed, along with the attendant future research possibilities.

6.1 Conclusions

This study builds on three different aspects: fashion industry, demand–supply management, and sustainability. Initially, it provided background on the textile-apparel industry, as FSC embrace both the apparel processing and textile production stages. While the textile and apparel manufacturing parts represent the supply side, the demand side is represented by brand and retail operations. This study considers that the retailer or brand handles activities other than manufacturing (e.g. sales, marketing, product development, design, product management). The demand and supply side are intentionally presented separately to exhibit their respective areas of importance, challenges, and priorities. The final and most important aspect of the study, sustainability, is brought up after delineating the corresponding highlights of the fashion industry and DSM. On the sustainability side, two major areas are emphasized, typical sustainability considerations as per TBL and product sustainability. The general sustainability aspects are not uncommon in fragmented form in industrial practices and academic research, which appear also in the form of SSCM. However, the product sustainability has not been considered as a system property for sustainability for SCOs. There is a great deal of research on different aspects of sustainability, including product sustainability in the form of a sustainable product. A sustainable product generally represents the green or sustainable feature of the product as standalone properties, but it is argued that product sustainability should consider other product-related aspects (e.g. life-cycle impact, quality, durability) in order to see it from a holistic point of view. This study argues that product centricity is the key to achieving total sustainability and that sustainability should be the integral part of the SCOs. The main aim of this research was to deepen the understanding of sustainability in the context of DSM in FSC and to formulate a substantive approach to achieving ultimate sustainability in the SCO. This compilation of knowledge is dedicated to answering the three research questions presented at the beginning, and the following sections are an endeavour to answer those.

6.1.1 Answer to research question one

What are the aspects of sustainability in the evolving trend of responsibility in the FSC?

The answer to question one provides a clearer view of what topics are regarded as sustainability related through literature review and further verified in Case studies. The overview of the fashion industry has shown the common challenges in the industry both from a business and a sustainability perspective. Two major trends, the global shift in manufacturing and FF, are highlighted. Growing concerns about sustainability among various stakeholders, including consumers, are another noticeable trend. Moreover, demand for responsible practices in business globally has intensified CSR practices. The evolving trend of sustainability can be split into environmental concern, social responsibility, and awareness related to products among consumers, although economic performance and stability are also considered important.

The study found that early research on sustainability mainly focused on environmental concerns, which is expected, as the textile industry is one of the most highly polluting, as has already been recognized by the early textile producers in developed countries. It is observed that the industry shift towards emerging countries has also resulted directly or indirectly, due to the fact that environmental requirements were getting more difficult and expensive to maintain. The third case company in downstream experienced similar challenges which forced them to move their production. Environmental sustainability concerns related to harmful substances and environmental pollution are addressed by imposing environmental requirements from the retailers, followed by voluntary environmental assessment. Besides legislative limits on harmful chemicals, retailers often develop their own RSL to control production. Although this is extensive and challenging, retailers have been successful in implementing through control in production as well as waste and laboratory tests. Industry initiatives like bluesign and Oeko-Tex STeP (Sustainable Textile Production) help retailers to restrict their manufacturing steps to produce safe products. Manufacturers adopt these systems in order to prove their commitment to sustainability, which is mainly done as a result of business concerns. However, complexity in implementation and increases in manufacturing costs restrict the wide use of such initiatives. Another trend is the increasing regulatory requirements by local, regional, or international authorities. This increases the product safety liability of the retailers, which also impacts suppliers.

Process optimization to reduce energy, water and chemical consumption in manufacturing can be considered another persistent trend, as it has direct influence on cost reduction. Forerunner brands with core technical expertise also cooperate with suppliers for process improvement. Academic research and development by equipment manufacturers, chemical producers, and professionals greatly impacts advancement. Brands are increasingly using more environmentally friendly materials (e.g. recycled, natural, organic) or greener processes like digital instead of conventional printing. Responsible companies are staying ahead of regulatory limits by forbidding potentially harmful substances (e.g. PFC, phthalate). LCA is adopted for measuring the impact to reduce their carbon footprint and often carbon compensation approach adopted if not able to reduce as part of CSR practice. CSR is the formal way to integrate and communicate sustainable practices with the stakeholders.

CSR is one early voluntary approach, often related to social condition improvement. Social compliance in the supply-chain is another growing concern in fashion industry, as exposed through media highlights, NGO activities, and few recent fatalities in the supplying countries. Poor working conditions, child labour, and discrimination are among the common phenomena in the apparel industry which are being addressed by multifaceted initiatives. Retailers often join different initiatives to assess the social performance (e.g. BSCI) or organize their own audit program. As a part of their responsibility, retailers also work directly with suppliers to improve their performance. A focus on social compliance focus is also commonplace among suppliers, either to secure their business or from a responsibility perspective. Responsible retailers and companies also commit to UNGC or SDG to make an impact on a global scale.

Consumers are also increasingly conscious of product quality, features, and origin. Information regarding product recall and administrative effort on product non-compliance also helps to raise awareness. They are also becoming more interested in sustainability aspects, and companies see it as valuable for achieving a competitive advantage. Sustainable consumption in fashion industry is seen as a rising trend, contrary to intentional obsolescence. Additionally, retailers are encouraging consumers to return old clothes, whereas on the supply-chain side, there are efforts to improve recyclability.

6.1.2 Answer to research question two

What are the key operational factors and position of sustainability on the demand and supply sides of the FSC?

The key operational factors, along with sustainability, are evaluated deeply in a two-layer evaluation process to highlight elements dominating on the demand and supply sides. Upstream case studies found product and general sustainability among the top priorities, while downstream cases revealed product and flexibility at the top, followed by service and sustainability. Unquestionably, product sustainability is the top focus throughout SCO as found in both literature review and Case studies where different product-related aspects are underlined and established as dominating factors for supply-chain design. Many propositions in the conceptual model are based on product sustainability, as this is required to secure business and the opportunity to sustain long-term in both down- and upstream. Lion et al. (2016) find in their research that sustainability practices extend from a single-firm level to a network level, to be implemented within a company's boundaries as well as in collaboration with supply network partners like suppliers. Therefore, true accomplishment of sustainability requires a holistic approach, and it cannot be limited by organizational boundaries.

Service and flexibility are found to be important on both sides and have an impact on sustainability. The FSC has transformed for agility for greater service in producing, delivering and selling the merchandise. Although there is nothing wrong with aiming for agility, the demand for greater flexibility and stress on lead-time reduction is impacting sustainability in many ways. Retailers' high dependency on weather and the latest trends results in last-minute changes in product assortment and order placement, keeping supply-chain under stress. Although the industry adapts to agility, but this unsustainable practice increases the chance of error. Furthermore, uncertain demand is also a problem in production and capacity planning, where agility is not favourable. The high fluctuation creates an unstable situation in production, where sometimes workers are laid off due to a lack of work, whereas in high demand they are urged to work overtime beyond legal boundaries and in an inhumane manner.

Cost is found significant in downstream but not in upstream. In the changed circumstances resulting from globalization, this is no longer the top criteria on the demand side; instead, product sustainability and agility are prized. The cost pressure in manufacturing emerged due to FF and the severest impact is on the supply side, as everywhere the cost graph is rising. Often the suppliers of apparel

products are in a dilemma, as the FF and supermarket retailers are rather large in volume and powerful. The competition is also strong among apparel manufacturers and among sourcing countries. It has the further effect of reducing the cost up the chain in material production. The quality of material, final product quality, and inclusion of sustainable features are difficult to achieve due to cost barriers. Low-cost products also promote unconscionable levels of consumption by consumers, which is a challenge in the downstream part in terms of waste creation and recycling.

The demanding downstream of the supply-chain is striving to find a balance, as the entire industry is under suppression for cost, but increasingly demanding. Quality criteria and regulatory requirements are becoming stricter. Compliance requirements are also increasing, but argument continues over the real welfare of workers. Therefore, total sustainability remains a very challenging issue, and the industry has taken an ameliorative approach where required. On the retailers' side, activities related to sustainability are mostly designed to fulfil the demand of downstream stakeholders and safeguard reputation, whereas on the supply side, they take it as a means to secure their business. It is revealed from the case studies that sustainability is not among the top focuses in the downstream, although it often appears as the most important. On the other hand, it has a better position on the supply side, which is due to their practical approach to fulfilling customers' requirements, even though the question remains how well it has been understood in terms of real improvement in social sustainability and environmental impact.

6.1.3 Answer to research question three

What is the substantive approach to managing the FSC in sustainably?

The conceptual model is presented in five phases (see Figure 15). At the beginning, the elements of sustainability hierarchy are presented as a compilation of various sustainability aspects on the strategic, planning, and operational levels. The feature of the hierarchy matrix is the inclusion of product sustainability as a fourth column beside the TBL. The main purpose is to display different important aspects which should be addressed in the theoretical operational model.

In the second phase, different elements of operational management are presented on both the demand and supply sides. As could be expected, the demand side consists of the typical retailers' operations, containing no manufacturing activities, and the supply side represents manufacturing- and supply-related activities. All the operational functions are represented as nodes which are

connected to present the interrelation of the functions in terms of activities. The demand side features the operational requirements from retail and consumers, while the supply side underlines the viability of demands in operations. It is noteworthy that the operational activities are mainly collected from the Case studies through deep analysis of the cases at both ends, although strategic- and planning-level elements are mainly collected from the literature.

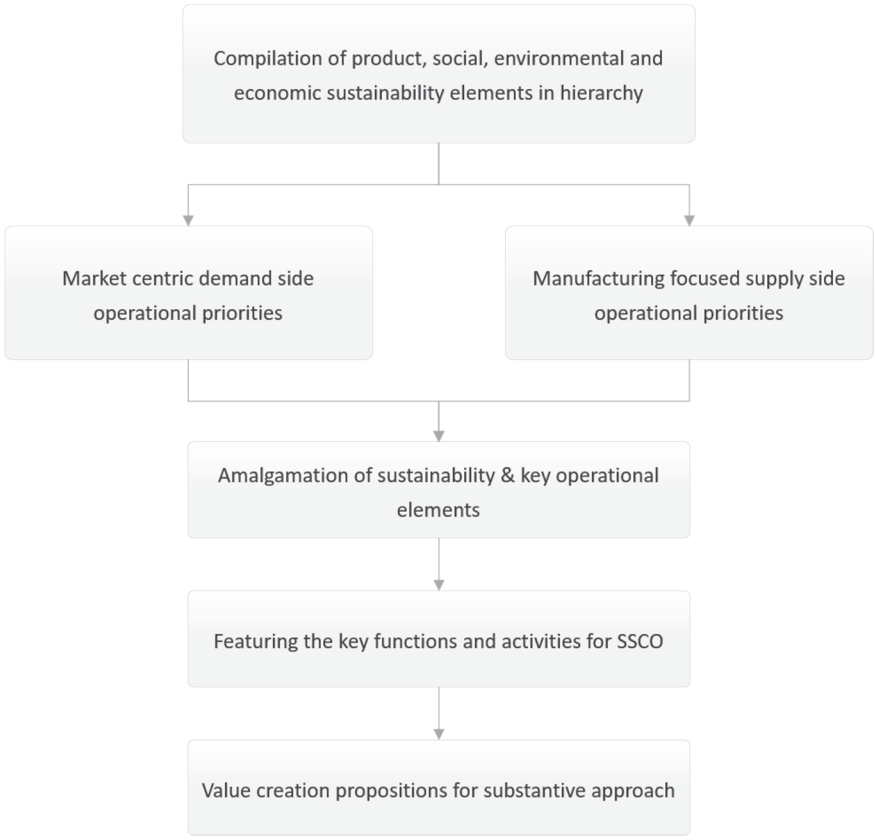

Fig. 15. Evolution of conceptual model.

The next phase is the amalgamation of the requirements and practicalities. It features the product through a holistic approach and reorganizes the present practices by addressing those needs. The inclusion of product sustainability takes a very distinct approach to organizing the SCO, based on product need, which further guides the upstream. A product sustainability-based strategy also substantiates the

actual need in order to truly address the total sustainability. If a product collection is based on natural fibre, the approach will be very different from that taken with synthetic fibre. The concerns are very different from social and environmental perspectives. This study argues that the process should be initiated from R&D and design, rather than considering those as supportive elements in the whole process. Excessive supply-chain focus, especially on performance, distracts from sustainability elements, which is the main barrier to integrating sustainability in SCOs. It should be seen as part of a whole system rather than an additional element of typical supply-chain factors. If sustainability, especially product sustainability, is not considered from the beginning in the planning and design phase, it cannot be imposed in manufacturing. For example, if a product would like to produce the lowest impact throughout its lifecycle, there is no alternative way but to design it in a manner which considers all possible impacts in different phases. An unconnected approach is the main barrier to total sustainability, as sustainably designed products require competence from the supplier side. Hence, the SCO from the retailer side should find the proper partner and plan with a substantive approach.

This is also the strategic stance of the company regarding what degree of sustainability they would like to include and how. This has an impact on their business and profitability. Inclusion of sustainability in a fragmented form is also not cost effective, as sustainability concerns appear as additional features and therefore at additional cost. For companies which have already adopted sustainability practices from the social and environmental side, it is rather simple to deliver according to product sustainability need. For example, if a product is required to be eco-certified, it is quite simple for them to achieve this with a partner that is already certified for the specific certificate. But if the supplier has to acquire certification for a specific supplier, this is not cost effective. In order to achieve total sustainability, the focal company on the retailer side must take the leading role from the strategic level. Sustainability must be included in the core part of the business strategy, which should be reflected at the planning level. At the planning level, organization of supply-chain is crucial for partnering with the right companies, with whom they will co-apply their vision on sustainability and also acquire appropriate assistance to implement their agenda on the operational level.

6.2 Research contribution and implications

6.2.1 Theoretical contribution

The findings of this research constitute a significant theoretical contribution to sustainable supply-chain research, which can be divided into two main areas. One is related to product sustainability, the other to managing demand and supply sustainably. Although research was based on the FSC, the knowledge can be utilized by other consumer product segments too.

In the theoretical analysis, different typical sustainability aspects are presented. The literature review has revealed that there are many studies on sustainability and sustainable SCM. The issue has been addressed in research mainly in the form of sustainability in SCM. In other studies, for example in CSR or environmental impact analysis, sustainability has appeared in a discrete manner. The topic is also commonly found in research in the textile apparel industry, especially on the environmental impact side. Nagurney and Yu (2012) state that the fashion and apparel industry faces vast challenges as well as opportunities in the reduction of its environmental impact globally. Therefore, the industry has proved attractive to researchers. Although early studies over recent decades attempted to extend the boundary of sustainable development to SCM, recent studies address that SSCM should deal with environmental and social issues based on the TBL standard (Zhang et al., 2018). However, these studies are mainly focused on elements of TBL and place importance on performance management both from a sustainability and a supply-chain point of view. From the product point of view, studies are made mainly in relation to sustainable products, where the criteria and approach for inclusion of green features are highlighted. There is also research into design for environment or design for sustainability-related issues, where emphasis is placed on sustainability-related issues in the design phase. Similar studies are also found on operational issues (e.g. design for manufacturability). On the product compliance side, product quality or regulatory requirements, recalls, and other issues appeared in a limited number of studies. This research brought those parts under the term of product sustainability, including green features, quality aspects, regulatory needs, product safety, durability, recyclability, and other aspects. The study also integrates the product sustainability in TBL to assert the necessity of product centricity to achieve total sustainability, which should begin from the product and be integrated into the strategic, planning, and operational levels.

Another important contribution of this study is to manage demand and supply from a sustainability point of view rather than considering those only from an operational point of view. It emphasizes the amalgamation of the functions and activities from the concept of DSCM to reduce the gap between the demand and supply sides and to see each activity from both a demand and supply point of view, as well as sustainability. It is an attempt to see the typical activities in the supply-chain from a sustainability perspective and to organize those by taking a total sustainability approach.

6.2.2 Managerial implications

The uniqueness of the study lies in its substantive approach to managing sustainability. The substantive approach is realized through the inclusion of the perspective of both demand and supply in management. The inclusion of product sustainability is a new concept according to the best of the researcher's knowledge; hence, such an operational model is newly introduced to practitioners in the SCM arena.

There are several different aspects which would facilitate the industry with a new dimension of thinking. First, the idea of including a product in total sustainability will assert the importance of the product perspective and provide impetus to begin the process from the product point of view. It has also shown the holistic approach of product sustainability by turning it around from sustainable products. As product risk management and fulfilment of regulatory requirements are becoming increasingly important globally, this research will complement this need. Product quality is a more important concern than ever before, due to growing awareness among consumers and the emphasis placed on it by the authorities (e.g. the EU). It is also stimulated continuously by the development of new regulations. Furthermore, green features of products are appreciated by consumers more than ever before, and retailers often use this as a sales argument. This study brings all those needs under one umbrella to be considered from the beginning of the process, which provides companies with an edge in product management, in terms of risk and opportunities. Second, the early assertion of product sustainability, and consideration of it from both the demand and supply perspectives, helps managers to control it at an early stage and reduce the risks. This also provides the opportunity to check and develop supplier capability. Third, the conceptual model will give the focal company a special framework for managing demand and supply in a feasible manner and prioritizes the activities in a collaborative approach.

6.3 Limitations and future research

This research has mainly focused on FSC, and it embraces several issues to achieve 'total sustainability'. Although the integration of the concept in SCO will be beneficial for the companies in both upstream and downstream, but it has also several limitations. The proposition embraced most of the issues appearing in the study, except the manufacturing part beyond material and yarn production and the post-consumer part on the downstream side. Because of the primary focus of the study, it was not able to accommodate other important aspects such as LCA. Although most of the elements of the total life-cycle have appeared in the research, the recycling of textiles in the post-consumer phase has not been considered. The integration of extended parts in both up and down stream could add more issues to enrich the model in wider aspects. This is an extensive topic and an emerging area of research in this industry. As a potential area for future research, the post-consumer phase could be integrated as a part of the DSM in a sustainable manner. According to McKinsey (2019), the lifespan of fashion products is being stretched as pre-owned, refurbished, repaired, and rental business models continue to evolve, constituting a major shift as consumers desire more variety, sustainability, and affordability. The report argues that the resale market could be larger than FF within ten years. The trend shifts and disruption in the industry will have a direct impact on both DSM, which requires further in-depth research.

The study has included twelve case companies on both the demand and supply sides, through which a diversified view of sustainability in practice is achieved. Although a considerable number of cases are used in supply side, which had a significant role in formulating the substantive conceptual model, it could be tested in practice. The integration of SMEs in case studies could also consider specific challenges in their niche. The time of case studies and interview might also have a possibility of biased judgement in some scores. However, multiple case studies reduce the probability of errors. The study has a strong product focus and asserts the importance of product sustainability as a part of total sustainability. This is a unique feature of this research in the context of generating knowledge of product centricity from different perspectives. Further research on product sustainability could quantify the impact through impact assessment.

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Appendices

Appendix 1

Table 20. Topics and Sub topics for interviews.

SC factors	Topic for questions and discussions	Objective
Cost	Inventory cost, freight cost, processing cost, manufacturing cost, shortage cost, supply cost, marketability, cost as customer driver, profit margin	Influence of cost in their operations and corresponding priorities
Product centricity & operational quality	Total quality management, product variance impact on quality, Standard product quality control procedure, quality assurance for raw material and in-process goods, strategic significance of quality	Significance of product quality and means for assurance
Service	Service level & capability, claim handling, customer requirement fulfilment, significance of cost in providing total value as service, service in changed circumstances, ability fulfil different customer requirements	Different dimension of service and influence of other parameters on it, e.g. Cost
Lead time	Lead-time complexity and management, on-time delivery and dependencies, impact of lead-time in changed circumstances, order cycle time, design influence on lead-time	lead-time related challenges and impact of variance
Flexibility	Product variance and impact, volume flexibility, manpower flexibility, supplier dependence on flexibility, supply flexibility, adaptation in unexpected changes,	Flexibility for greater service and meet customer demand
Efficiency / productivity	Management method, e.g. lean, impact of product variance in line setup and change time, impact of lot size in productivity, management of non-value adding process, impact of demand smoothness on efficiency	Efficiency management to adapt changes and reduce cost
Supplier engagement	Dependence of supplier performance on raw materials production, forecasting, planning from customers, use of ERP (Enterprise resource planning), dependency on customers on different variables, focused supplier pool, co-operation with buyers and suppliers,	Supply chain co-ordination for efficient operation and greater value addition
Sustainability	Significance of sustainability, social compliance, environmental responsibility, chemical safety, importance of compliant product, raw materials from sustainable sources	Sustainability consideration in operations and product sustainability

Appendix 2

Table 21. Members of the focus group.

	Participants profile	Position in SC	Experiences & expertise
1	Owner & Managing Director Importer & agent of materials & ready products	Demand side of the chain, Finland	Over 24 years of experience in textile and fashion industry downstream demand side. Experience in dealing with the suppliers from Europe and outside.
2	Head Designer Fashion brand & retailer	Demand side of the chain Finland	23 years of experience in designing of clothing and product management. Extensive experience on consumer demand on sustainability and product requirements.
3	Researcher & marketing professional Fashion retailing & CSR research	Demand side / Consumer Denmark	Experience in retail environment from the consumer demand on product and CSR perspective.
4	Department Head – Marketing & Merchandising, Apparel production	Supply side Bangladesh	Over 22 years of experience in textile industry and dealing with the western brands. Knowledgeable in product & sustainability related requirement from the buyers. Besides, deep understanding on the challenges in manufacturing.
5	Senior Merchandiser Apparel production	Supply side Bangladesh	Hands on experience in manufacturing and production planning, as well as challenge related to demand and supply. Additional merchandising experience provided knowledge on product compliance and regulatory requirements.

Appendix 3 Analytical Hierarchy Process (AHP)

Table 22. Fundamental scale of absolute numbers (Saaty, 1980).

Intensity of importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favour one activity over another
5	Essential or strong importance	Experience and judgment strongly favour one activity over another
7	Demonstrated importance	An activity is strongly favoured and its dominance is demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2.4.6.8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals of above	If an activity has one of the above numbers compared with a second activity, then the second activity has the reciprocal value when compared to the first	

Table 23. Random index (RI) for factors used in decision making (Saaty, 1980).

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Appendix 4 Case 1 data tables

Table 24. Pair-wise comparison key supply chain performance factors for case 1.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.20	0.33	0.33	0.33	3.00	3.00	0.14	0.559	0.050
Product	5.00	1.00	3.00	5.00	5.00	3.00	3.00	0.33	2.407	0.216
Service	3.00	0.33	1.00	3.00	3.00	0.33	3.00	0.20	1.076	0.097
Lead-time	3.00	0.20	0.33	1.00	1.00	0.33	3.00	0.20	0.669	0.060
Flexibility	3.00	0.20	0.33	1.00	1.00	0.33	3.00	0.14	0.641	0.058
Productivity	0.33	0.33	3.00	3.00	3.00	1.00	3.00	0.20	1.076	0.097
Supplier	0.33	0.33	0.33	0.33	0.33	0.33	1.00	0.14	0.344	0.031
Sustainability	7.00	3.00	5.00	5.00	7.00	5.00	7.00	1.00	4.352	0.391
Sum	*22.67*	*5.60*	*13.33*	*18.67*	*20.67*	*13.33*	*26.00*	*2.36*	*11.124*	*1.000*
Sum * PV	1.139	1.212	1.290	1.122	1.191	1.290	0.804	0.924	8.972	
Lambda-max	8.972									
CI	0.139									
CR	0.098									

Table 25. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Sustainability	0.391	0.391
Significance of compliant product	0.391	0.153
Social compliance certification	0.391	0.153
Sustainability vs flexibility	0.151	0.059
Environmental compliance	0.067	0.026
Product quality	0.216	0.216
Product compliance	0.520	0.112
Quality management	0.201	0.043
Quality assurance	0.201	0.043
Quality yield	0.078	0.017
Service	0.097	0.097
Customer satisfaction	0.637	0.062
Claim handling	0.258	0.025
On demand service	0.105	0.010
Productivity	0.097	0.097
Production management	0.637	0.062
Dependency on efficiency factors	0.258	0.025
Focused product category	0.105	0.010
Lead time	0.060	0.060
Influence of design complicacy	0.558	0.033

Lead time management	0.249	0.015
Capacity management	0.096	0.006
Production planning & scheduling	0.096	0.006
Flexibility	0.058	0.058
Influece on compliance	0.637	0.037
Readiness for change	0.258	0.015
Influence on efficiency	0.105	0.006
Cost	0.050	0.050
Processing cost	0.558	0.028
Management cost	0.249	0.012
Marketability cost	0.096	0.005
Profitability	0.096	0.005
Supplier performance	0.031	0.031
Assurance of compliance	0.637	0.020
Transparency & control in the SC	0.258	0.008
Supplier management	0.105	0.003

Appendix 5 Case 2 data tables

Table 26. Pair-wise comparison key supply chain performance factors for case 2.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.33	3.00	3.00	3.00	1.00	5.00	3.00	1.846	0.189
Product	3.00	1.00	3.00	3.00	3.00	3.00	3.00	3.00	2.615	0.267
Service	0.33	0.33	1.00	0.33	1.00	0.33	3.00	3.00	0.760	0.078
Lead-time	0.33	0.33	3.00	1.00	1.00	0.33	3.00	3.00	1.000	0.102
Flexibility	0.33	0.33	1.00	1.00	1.00	0.33	3.00	3.00	0.872	0.089
Productivity	1.00	0.33	3.00	3.00	3.00	1.00	5.00	3.00	1.846	0.189
Supplier	0.20	0.33	0.33	0.33	0.33	0.20	1.00	0.33	0.337	0.034
Sustainability	0.33	0.33	0.33	0.33	0.33	0.33	3.00	1.00	0.503	0.051
Sum	*6.53*	*3.33*	*14.67*	*12.00*	*12.67*	*6.53*	*26.00*	*19.33*	*9.779*	*1.000*
Sum * PV	1.233	0.891	1.140	1.227	1.129	1.233	0.895	0.995	8.744	
Lambda-max	8.744									
CI	0.106									
CR	0.075									

Table 27. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Product quality	0.267	0.267
Quality management	0.558	0.149
Product compliance	0.249	0.066
Quality assurance	0.096	0.026
Quality yield	0.096	0.026
Cost	0.189	0.189
Management cost	0.558	0.105
Processing cost	0.249	0.047
Marketibility cost	0.096	0.018
Profitability	0.096	0.018
Productivity	0.189	0.189
Dependency on efficiency factors	0.637	0.120
Production management	0.258	0.049
Focused product category	0.105	0.020
Lead time	0.102	0.102
Lead time management	0.391	0.040
Production planning & scheduling	0.391	0.040
Capacity management	0.151	0.015
Influence of design complicacy	0.067	0.007
Flexibility	0.089	0.089

Readiness for change	0.637	0.057
Influence on efficiency	0.258	0.023
Influece on compliance	0.105	0.009
Service	0.078	0.078
On demand service	0.637	0.050
Customer satisfaction	0.258	0.020
Claim handling	0.105	0.008
Sustainability	0.051	0.051
Significance of compliant product	0.487	0.025
Social compliance certification	0.233	0.012
Environmental compliance	0.233	0.012
Sustainability vs flexibility	0.048	0.002
Supplier performance	0.034	0.034
Supplier management	0.600	0.020
Transparency & control in the SC	0.200	0.007
Assurance of compliance	0.200	0.007

Appendix 6 Case 3 data tables

Table 28. Pair-wise comparison key supply chain performance factors for case 3.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.33	3.00	3.00	3.00	1.00	7.00	3.00	1.926	0.184
Product	3.00	1.00	3.00	5.00	3.00	3.00	5.00	5.00	3.167	0.303
Service	0.33	0.33	1.00	3.00	1.00	0.33	6.00	1.00	0.951	0.091
Lead-time	0.33	0.20	0.33	1.00	0.33	0.20	1.00	1.00	0.443	0.042
Flexibility	0.33	0.33	1.00	3.00	1.00	0.33	3.00	3.00	1.000	0.096
Productivity	1.00	0.33	3.00	5.00	3.00	1.00	5.00	5.00	2.098	0.201
Supplier	0.14	0.20	0.17	1.00	0.33	0.20	1.00	1.00	0.365	0.035
Sustainability	0.33	0.20	1.00	1.00	0.33	0.20	1.00	1.00	0.508	0.049
Sum	*6.48*	*2.93*	*12.50*	*22.00*	*12.00*	*6.27*	*29.00*	*20.00*	*10.458*	*1.000*
Sum * PV	1.192	0.888	1.136	0.932	1.148	1.257	1.013	0.972	8.538	
Lambda-max	8.538									
CI	0.077									
CR	0.055									

Table 29. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Product quality	0.303	0.303
Quality assurance	0.391	0.118
Quality yield	0.391	0.118
Product compliance	0.151	0.046
Quality management	0.067	0.020
Productivity	0.201	0.201
Dependency on efficiency factors	0.637	0.128
Production management	0.258	0.052
Focused product category	0.105	0.021
Cost	0.184	0.184
Management cost	0.520	0.096
Processing cost	0.201	0.037
Marketibility cost	0.201	0.037
Profitability	0.078	0.014
Flexibility	0.096	0.096
Influence on efficiency	0.637	0.061
Readiness for change	0.258	0.025
Influece on compliance	0.105	0.010
Service	0.091	0.091
Customer satisfaction	0.637	0.058

On demand service	0.258	0.023
Claim handling	0.105	0.010
Sustainability	0.049	0.049
Significance of compliant product	0.397	0.019
Social compliance certification	0.397	0.019
Environmental compliance	0.160	0.008
Sustainability vs flexibility	0.047	0.002
Lead time	0.042	0.042
Influence of design complicacy	0.391	0.016
Production planning & scheduling	0.391	0.016
Lead time management	0.151	0.006
Capacity management	0.067	0.003
Supplier performance	0.035	0.035
Assurance of compliance	0.637	0.022
Supplier management	0.258	0.009
Transparency & control in the SC	0.105	0.004

Appendix 7 Case 4 data tables

Table 30. Pair-wise comparison key supply chain performance factors for case 4.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.20	0.20	0.33	3.00	1.00	0.33	0.14	0.457	0.039
Product	5.00	1.00	1.00	5.00	3.00	3.00	5.00	0.20	1.968	0.170
Service	5.00	1.00	1.00	1.00	3.00	3.00	5.00	0.20	1.609	0.139
Lead-time	3.00	0.20	1.00	1.00	0.33	3.00	1.00	0.14	0.736	0.064
Flexibility	0.33	0.33	0.33	3.00	1.00	3.00	3.00	0.14	0.784	0.068
Productivity	1.00	0.33	0.33	0.33	0.33	1.00	3.00	0.14	0.519	0.045
Supplier	3.00	0.20	0.20	1.00	0.33	0.33	1.00	0.14	0.457	0.039
Sustainability	7.00	5.00	5.00	7.00	7.00	7.00	7.00	1.00	5.046	0.436
Sum	*25.33*	*8.27*	*9.07*	*18.67*	*18.00*	*21.33*	*25.33*	*2.11*	*11.576*	*1.000*
Sum * PV	1.000	1.405	1.260	1.186	1.219	0.957	1.000	0.922	8.950	
Lambda-max	8.950									
CI	0.136									
CR	0.096									

Table 31. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Sustainability	0.436	0.436
Environmental compliance	0.502	0.219
Sustainability vs flexibility	0.220	0.096
Significance of compliant product	0.220	0.096
Social compliance certification	0.058	0.025
Product quality	0.170	0.170
Product compliance	0.391	0.066
Quality management	0.391	0.066
Quality assurance	0.151	0.026
Quality yield	0.067	0.011
Service	0.139	0.139
Customer satisfaction	0.600	0.083
On demand service	0.200	0.028
Claim handling	0.200	0.028
Flexibility	0.068	0.068
Influece on compliance	0.600	0.041
Influence on efficiency	0.200	0.014
Readiness for change	0.200	0.014
Lead time	0.064	0.064
Lead time management	0.520	0.033

Production planning & scheduling	0.201	0.013
Influence of design complicacy	0.201	0.013
Capacity management	0.078	0.005
Productivity	0.045	0.045
Production management	0.637	0.029
Dependency on efficiency factors	0.258	0.012
Focused product category	0.105	0.005
Cost	0.039	0.039
Management cost	0.558	0.022
Processing cost	0.249	0.010
Marketibility cost	0.096	0.004
Profitability	0.096	0.004
Supplier performance	0.039	0.039
Assurance of compliance	0.637	0.025
Supplier management	0.258	0.010
Transparency & control in the SC	0.105	0.004

Appendix 8 Case 5 data tables

Table 32. Pair-wise comparison key supply chain performance factors for case 5.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.33	0.20	0.33	1.00	1.00	0.33	0.20	0.443	0.043
Product	3.00	1.00	3.00	5.00	5.00	5.00	5.00	1.00	2.943	0.283
Service	5.00	0.33	1.00	1.00	1.00	3.00	5.00	0.20	1.223	0.118
Lead-time	3.00	0.20	1.00	1.00	1.00	3.00	3.00	0.20	1.010	0.097
Flexibility	1.00	0.20	1.00	1.00	1.00	0.33	3.00	0.20	0.669	0.064
Productivity	1.00	0.20	0.33	0.33	3.00	1.00	3.00	0.33	0.713	0.069
Supplier	3.00	0.20	0.20	0.33	0.33	0.33	1.00	0.33	0.443	0.043
Sustainability	5.00	1.00	5.00	5.00	5.00	3.00	3.00	1.00	2.943	0.283
Sum	*22.00*	*3.47*	*11.73*	*14.00*	*17.33*	*16.67*	*23.33*	*3.47*	*10.386*	*1.000*
Sum * PV	0.938	0.982	1.382	1.361	1.116	1.144	0.995	0.982	8.901	
Lambda-max	8.901									
CI	0.129									
CR	0.091									

Table 33. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Sustainability	0.283	0.283
Social compliance certification	0.391	0.111
Environmental compliance	0.391	0.111
Sustainability vs flexibility	0.151	0.043
Significance of compliant product	0.067	0.019
Product quality	0.283	0.283
Quality management	0.558	0.158
Product compliance	0.249	0.070
Quality assurance	0.096	0.027
Quality yield	0.096	0.027
Service	0.118	0.118
On demand service	0.637	0.075
Customer satisfaction	0.258	0.030
Claim handling	0.105	0.012
Lead time	0.097	0.097
Lead time management	0.558	0.054
Influence of design complicacy	0.249	0.024
Production planning & scheduling	0.096	0.009
Capacity management	0.096	0.009
Productivity	0.069	0.069

Production management	0.637	0.044
Dependency on efficiency factors	0.258	0.018
Focused product category	0.105	0.007
Flexibility	0.064	0.064
Influece on compliance	0.637	0.041
Readiness for change	0.258	0.017
Influence on efficiency	0.105	0.007
Cost	0.043	0.043
Processing cost	0.520	0.022
Management cost	0.201	0.009
Profitability	0.201	0.009
Marketibility cost	0.078	0.003
Supplier performance	0.043	0.043
Assurance of compliance	0.637	0.027
Supplier management	0.258	0.011
Transparency & control in the SC	0.105	0.005

Appendix 9 Case 6 data tables

Table 34. Pair-wise comparison key supply chain performance factors for case 6.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.33	0.20	0.20	0.33	0.33	1.00	0.14	0.347	0.031
Product	3.00	1.00	3.00	3.00	3.00	3.00	1.00	0.20	1.625	0.147
Service	5.00	0.33	1.00	1.00	1.00	3.00	3.00	0.20	1.147	0.104
Lead-time	5.00	0.33	1.00	1.00	1.00	5.00	7.00	0.20	1.359	0.123
Flexibility	3.00	0.33	1.00	1.00	1.00	3.00	1.00	0.20	0.938	0.085
Productivity	3.00	0.33	0.33	0.20	0.33	1.00	3.00	0.14	0.559	0.050
Supplier	1.00	1.00	0.33	0.14	1.00	0.33	1.00	0.14	0.467	0.042
Sustainability	7.00	5.00	5.00	5.00	5.00	7.00	7.00	1.00	4.639	0.419
Sum	28.00	8.67	11.87	11.54	12.67	22.67	24.00	2.23	11.082	1.000
Sum * PV	0.878	1.271	1.228	1.416	1.072	1.143	1.012	0.933	8.953	
Lambda-max	8.953									
CI	0.136									
CR	0.097									

Table 35. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Sustainability	0.419	0.419
Significance of compliant product	0.397	0.166
Social compliance certification	0.397	0.166
Environmental compliance	0.160	0.067
Sustainability vs flexibility	0.047	0.020
Product quality	0.147	0.147
Quality assurance	0.525	0.077
Quality management	0.212	0.031
Product compliance	0.212	0.031
Quality yield	0.051	0.007
Lead time	0.123	0.123
Lead time management	0.394	0.048
Production planning & scheduling	0.394	0.048
Influence of design complicacy	0.134	0.016
Capacity management	0.077	0.009
Service	0.104	0.104
Customer satisfaction	0.637	0.066
Claim handling	0.258	0.027

On demand service	0.105	0.011
Flexibility	0.085	0.085
Readiness for change	0.637	0.054
Influece on compliance	0.258	0.022
Influence on efficiency	0.105	0.009
Productivity	0.050	0.05
Production management	0.637	0.032
Dependency on efficiency factors	0.258	0.013
Focused product category	0.105	0.005
Supplier performance	0.042	0.042
Assurance of compliance	0.429	0.018
Supplier management	0.429	0.018
Transparency & control in the SC	0.143	0.006
Cost	0.031	0.031
Management cost	0.520	0.016
Marketibility cost	0.201	0.006
Processing cost	0.201	0.006
Profitability	0.078	0.002

Appendix 10 Case 7 data tables

Table 36. Pair-wise comparison key supply chain performance factors for case 7.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.33	0.33	0.33	0.33	1.00	3.00	0.20	0.542	0.052
Product	3.00	1.00	3.00	5.00	3.00	3.00	3.00	1.00	2.430	0.234
Service	3.00	0.33	1.00	3.00	3.00	3.00	3.00	0.33	1.510	0.145
Lead-time	3.00	0.20	0.33	1.00	1.00	1.00	3.00	0.20	0.767	0.074
Flexibility	3.00	0.33	0.33	1.00	1.00	0.33	3.00	0.20	0.713	0.069
Productivity	1.00	0.33	0.33	1.00	3.00	1.00	3.00	0.20	0.818	0.079
Supplier	0.33	0.33	0.33	0.33	0.33	0.33	1.00	0.14	0.344	0.033
Sustainability	5.00	1.00	3.00	5.00	5.00	5.00	7.00	1.00	3.272	0.315
Sum	*19.33*	*3.87*	*8.67*	*16.67*	*16.67*	*14.67*	*26.00*	*3.28*	*10.395*	*1.000*
Sum * PV	1.007	0.904	1.259	1.230	1.143	1.154	0.860	1.031	8.589	
Lambda-max	8.589									
CI	0.084									
CR	0.060									

Table 37. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Sustainability	0.315	0.315
Social compliance certification	0.520	0.164
Significance of compliant product	0.201	0.063
Sustainability vs flexibility	0.201	0.063
Environmental compliance	0.078	0.025
Product quality	0.234	0.234
Quality assurance	0.391	0.091
Product compliance	0.391	0.091
Quality management	0.152	0.036
Quality yield	0.067	0.016
Service	0.145	0.145
Claim handling	0.637	0.092
Customer satisfaction	0.258	0.037
On demand service	0.105	0.015
Productivity	0.079	0.079
Production management	0.649	0.051
Dependency on efficiency factors	0.279	0.022
Focused product category	0.072	0.006
Lead time	0.074	0.074
Lead time management	0.391	0.029

Production planning & scheduling	0.391	0.029
Influence of design complicacy	0.151	0.011
Capacity management	0.067	0.005
Flexibility	0.069	0.069
Readiness for change	0.637	0.044
Influence on efficiency	0.258	0.018
Influece on compliance	0.105	0.007
Cost	0.052	0.052
Processing cost	0.520	0.027
Management cost	0.201	0.010
Profitability	0.201	0.010
Marketibility cost	0.078	0.004
Supplier performance	0.033	0.033
Transparency & control in the SC	0.637	0.021
Supplier management	0.258	0.009
Assurance of compliance	0.105	0.003

Appendix 11 Case 8 data tables

Table 38. Pair-wise comparison key supply chain performance factors for case 8.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.20	0.20	0.33	3.00	1.00	1.00	0.20	0.547	0.054
Product	5.00	1.00	3.00	3.00	3.00	5.00	3.00	1.00	2.590	0.258
Service	5.00	0.33	1.00	3.00	5.00	3.00	3.00	0.33	1.715	0.171
Lead-time	3.00	0.33	0.33	1.00	3.00	3.00	3.00	0.33	1.147	0.114
Flexibility	0.33	0.33	0.20	0.33	1.00	5.00	3.00	0.33	0.662	0.066
Productivity	1.00	0.20	0.33	0.33	0.20	1.00	3.00	0.33	0.508	0.051
Supplier	1.00	0.33	0.33	0.33	0.33	0.33	1.00	0.33	0.439	0.044
Sustainability	5.00	1.00	3.00	3.00	3.00	3.00	3.00	1.00	2.430	0.242
Sum	*21.33*	*3.73*	*8.40*	*11.33*	*18.53*	*21.33*	*20.00*	*3.87*	*10.039*	*1.000*
Sum * PV	1.162	0.963	1.435	1.295	1.223	1.080	0.874	0.936	8.969	
Lambda-max	8.969									
CI	0.138									
CR	0.098									

Table 39. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Product quality	0.258	0.258
Quality assurance	0.391	0.101
Quality yield	0.391	0.101
Quality management	0.152	0.039
Product compliance	0.067	0.017
Sustainability	0.242	0.242
Environmental compliance	0.520	0.126
Significance of compliant product	0.201	0.049
Sustainability vs flexibility	0.201	0.049
Social compliance certification	0.078	0.019
Service	0.171	0.171
Customer satisfaction	0.637	0.109
On demand service	0.258	0.044
Claim handling	0.105	0.018
Lead time	0.114	0.114
Influence of design complicacy	0.520	0.059

Lead time management	0.201	0.023
Production planning & scheduling	0.201	0.023
Capacity management	0.078	0.009
Flexibility	0.066	0.066
Readiness for change	0.637	0.042
Influence on efficiency	0.258	0.017
Influece on compliance	0.105	0.007
Cost	0.054	0.054
Processing cost	0.558	0.030
Profitability	0.249	0.013
Management cost	0.096	0.005
Marketibility cost	0.096	0.005
Productivity	0.051	0.051
Focused product category	0.637	0.032
Production management	0.258	0.013
Dependency on efficiency factors	0.105	0.005
Supplier performance	0.044	0.044
Assurance of compliance	0.637	0.028
Supplier management	0.258	0.011
Transparency & control in the SC	0.105	0.005

Appendix 12 Case 9 data tables

Table 40. Pair-wise comparison key supply chain performance factors for case 9.

	Cost	Product	Service	Lead-time	Flexibility	Productivity	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.14	0.33	0.33	0.33	3.00	3.00	0.14	0.536	0.044
Product	7.00	1.00	5.00	3.00	3.00	9.00	7.00	0.20	2.817	0.229
Service	3.00	0.20	1.00	1.00	0.33	3.00	1.00	0.14	0.736	0.060
Lead-time	3.00	0.33	1.00	1.00	1.00	3.00	3.00	0.14	1.032	0.084
Flexibility	3.00	0.33	3.00	1.00	1.00	3.00	3.00	0.14	1.184	0.096
Productivity	0.33	0.11	0.33	0.33	0.33	1.00	3.00	0.14	0.395	0.032
Supplier	0.33	0.14	1.00	0.33	0.33	0.33	1.00	0.14	0.355	0.029
Sustainability	7.00	5.00	7.00	7.00	7.00	7.00	7.00	1.00	5.263	0.427
Sum	*24.67*	*7.26*	*18.67*	*14.00*	*13.33*	*29.33*	*28.00*	*2.06*	*12.317*	*1.000*
Sum * PV	1.073	1.661	1.115	1.173	1.282	0.940	0.807	0.879	8.930	
Lambda-max	8.930									
CI	0.133									
CR	0.094									

Table 41. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Sustainability	0.427	0.427
Significance of compliant product	0.520	0.222
Sustainability vs flexibility	0.201	0.086
Social compliance certification	0.201	0.086
Environmental compliance	0.078	0.033
Product quality	0.229	0.229
Product compliance	0.564	0.129
Quality assurance	0.263	0.060
Quality yield	0.118	0.027
Quality management	0.055	0.013
Flexibility	0.096	0.096
Readiness for change	0.637	0.061
Influece on compliance	0.258	0.025
Influence on efficiency	0.105	0.010
Lead time	0.084	0.084
Lead time management	0.564	0.047
Influence of design complicacy	0.263	0.022
Production planning & scheduling	0.118	0.010
Capacity management	0.055	0.005
Service	0.060	0.060

Customer satisfaction	0.649	0.039
Claim handling	0.279	0.017
On demand service	0.072	0.004
Cost	0.044	0.044
Processing cost	0.654	0.029
Management cost	0.191	0.008
Marketibility cost	0.077	0.003
Profitability	0.077	0.003
Productivity	0.032	0.032
Focused product category	0.637	0.020
Dependency on efficiency factors	0.258	0.008
Production management	0.105	0.003
Supplier performance	0.029	0.029
Transparency & control in the SC	0.637	0.018
Assurance of compliance	0.258	0.007
Supplier management	0.105	0.003

Appendix 13 Upstream case studies data tables

Table 42. Pair-wise comparison key SC performance factors for upstream cases.

	Cost	Product	Service	Lead-time	Flexibility	Efficiency	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.27	0.87	0.91	1.59	1.37	2.63	0.80	0.996	0.108
Product	3.74	1.00	3.00	4.11	3.44	4.11	3.89	1.33	2.760	0.298
Service	1.15	0.33	1.00	1.81	2.04	2.11	3.56	0.62	1.267	0.137
Lead-time	1.10	0.24	0.55	1.00	1.07	2.10	3.00	0.60	0.938	0.101
Flexibility	0.63	0.29	0.49	0.93	1.00	1.74	2.78	0.82	0.870	0.094
Efficiency	0.73	0.24	0.47	0.48	0.57	1.00	3.44	1.06	0.733	0.079
Supplier	0.38	0.26	0.28	0.33	0.36	0.29	1.00	0.30	0.361	0.039
Sustainability	1.25	0.75	1.60	1.66	1.22	0.95	3.32	1.00	1.328	0.144
Sum	*9.98*	*3.39*	*8.27*	*11.24*	*11.31*	*13.67*	*23.61*	*6.52*	*9.254*	*1.000*
Sum * PV	1.074	1.011	1.132	1.139	1.063	1.083	0.921	0.936	8.360	
Lambda-max	8.360									
CI	0.051									
CR	0.036									

Appendix 14 Case 10 data tables

Table 43. Pair-wise comparison key supply chain performance factors for case 10.

	Cost	Product	Service	Lead-time	Flexibility	Efficiency	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.33	0.33	0.33	0.14	0.33	0.20	0.33	0.323	0.031
Product	3.00	1.00	5.00	3.00	0.33	3.00	3.00	5.00	2.258	0.217
Service	3.00	0.20	1.00	0.33	0.20	3.00	1.00	3.00	0.880	0.085
lead-time	3.00	0.33	3.00	1.00	0.33	3.00	1.00	3.00	1.316	0.127
Flexibility	7.00	3.00	5.00	3.00	1.00	5.00	3.00	3.00	3.303	0.318
Efficiency	3.00	0.33	0.33	0.33	0.20	1.00	0.33	3.00	0.621	0.060
Supplier	5.00	0.33	1.00	1.00	0.33	3.00	1.00	3.00	1.223	0.118
Sustainability	3.00	0.20	0.33	0.33	0.33	0.33	0.33	1.00	0.472	0.045
Sum	*28.00*	*5.73*	*16.00*	*9.33*	*2.88*	*18.67*	*9.87*	*21.33*	*10.396*	*1.000*
Sum * PV	0.869	1.245	1.355	1.182	0.914	1.116	1.161	0.969	8.809	
Lambda-max	8.809									
CI	0.116									
CR	0.082									

Table 44. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Flexibility	0.318	0.318
Influece on compliance	0.637	0.203
Readiness for change	0.258	0.082
Influence on efficiency	0.105	0.033
Product quality	0.217	0.217
Product compliance	0.564	0.122
Quality assurance	0.263	0.057
Quality yield	0.118	0.026
Quality management	0.055	0.012
Lead time	0.127	0.127
Lead time management	0.654	0.083
Production planning & scheduling	0.191	0.024
Influence of design complicacy	0.077	0.010
Capacity management	0.077	0.010
Supplier performance	0.118	0.118
Transparency & control in the SC	0.637	0.075
Assurance of compliance	0.258	0.030
Supplier management	0.105	0.012
Service	0.085	0.085
Customer satisfaction	0.618	0.053

Claim handling	0.297	0.025
On demand service	0.086	0.007
Productivity	0.060	0.06
Focused product category	0.649	0.039
Dependency on efficiency factors	0.279	0.017
Production management	0.072	0.004
Sustainability	0.045	0.045
Significance of compliant product	0.565	0.025
Social compliance certification	0.270	0.012
Environmental compliance	0.126	0.006
Sustainability vs flexibility	0.039	0.002
Cost	0.031	0.031
Management cost	0.558	0.017
Marketibility cost	0.249	0.008
Processing cost	0.096	0.003
Profitability	0.096	0.003

Appendix 15 Case 11 data tables

Table 45. Pair-wise comparison key supply chain performance factors for case 11.

	Cost	Product	Service	Lead-time	Flexibility	Efficiency	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.20	0.20	0.20	0.14	1.00	0.20	0.14	0.275	0.025
Product	5.00	1.00	5.00	5.00	3.00	5.00	5.00	3.00	3.599	0.322
Service	5.00	0.20	1.00	3.00	0.20	3.00	3.00	0.33	1.076	0.096
Lead-time	5.00	0.20	0.33	1.00	0.33	1.00	1.00	0.20	0.621	0.056
Flexibility	7.00	0.33	5.00	3.00	1.00	3.00	3.00	0.33	1.789	0.160
Efficiency	1.00	0.20	0.33	1.00	0.33	1.00	1.00	0.20	0.508	0.046
Supplier	5.00	0.20	0.33	1.00	0.33	1.00	1.00	0.20	0.621	0.056
Sustainability	7.00	0.33	3.00	5.00	3.00	5.00	5.00	1.00	2.675	0.240
Sum	*36.00*	*2.67*	*15.20*	*19.20*	*8.34*	*20.00*	*19.20*	*5.41*	*11.165*	*1.000*
Sum * PV	0.886	0.859	1.465	1.069	1.337	0.910	1.069	1.296	8.891	
Lambda-max	8.891									
CI	0.127									
CR	0.090									

Table 46. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Product quality	0.322	0.322
Product compliance	0.520	0.167
Quality assurance	0.201	0.065
Quality yield	0.201	0.065
Quality management	0.078	0.025
Sustainability	0.240	0.240
Significance of compliant product	0.558	0.134
Environmental compliance	0.249	0.060
Sustainability vs flexibility	0.096	0.023
Social compliance certification	0.096	0.023
Flexibility	0.160	0.16
Readiness for change	0.649	0.104
Influece on compliance	0.279	0.045
Influence on efficiency	0.072	0.012
Service	0.096	0.096
Customer satisfaction	0.637	0.061
Claim handling	0.258	0.025
On demand service	0.105	0.010
Lead time	0.056	0.056
Lead time management	0.654	0.037

Capacity management	0.191	0.011
Influence of design complicacy	0.077	0.004
Production planning & scheduling	0.077	0.004
Supplier performance	0.056	0.056
Supplier management	0.731	0.041
Transparency & control in the SC	0.188	0.011
Assurance of compliance	0.081	0.005
Productivity	0.046	0.046
Focused product category	0.649	0.030
Dependency on efficiency factors	0.279	0.013
Production management	0.072	0.003
Cost	0.025	0.025
Management cost	0.558	0.014
Marketibility cost	0.249	0.006
Processing cost	0.096	0.002
Profitability	0.096	0.002

Appendix 16 Case 12 data tables

Table 47. Pair-wise comparison key supply chain performance factors for case 12.

	Cost	Product	Service	Lead-time	Flexibility	Efficiency	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.33	1.00	1.00	0.33	0.20	0.33	0.14	0.425	0.043
Product	3.00	1.00	3.00	5.00	3.00	3.00	3.00	1.00	2.430	0.246
Service	1.00	0.33	1.00	3.00	3.00	3.00	3.00	0.33	1.316	0.133
Lead-time	1.00	0.20	0.33	1.00	0.33	3.00	3.00	0.33	0.713	0.072
Flexibility	3.00	0.33	0.33	3.00	1.00	3.00	3.00	0.33	1.147	0.116
Efficiency	5.00	0.33	0.33	0.33	0.33	1.00	0.33	0.33	0.536	0.054
Supplier	3.00	0.33	0.33	0.33	0.33	3.00	1.00	0.20	0.621	0.063
Sustainability	7.00	1.00	3.00	3.00	3.00	3.00	5.00	1.00	2.701	0.273
Sum	*24.00*	*3.87*	*9.33*	*16.67*	*11.33*	*19.20*	*18.67*	*3.68*	*9.890*	*1.000*
Sum * PV	1.031	0.950	1.242	1.201	1.315	1.041	1.173	1.004	8.957	
Lambda-max	8.957									
CI	0.137									
CR	0.097									

Table 48. Global weight of the key supply chain performance factors and sub factors.

	Local weight	Global weight
Sustainability	0.273	0.273
Environmental compliance	0.564	0.154
Significance of compliant product	0.263	0.072
Sustainability vs flexibility	0.118	0.032
Social compliance certification	0.055	0.015
Product quality	0.246	0.246
Quality yield	0.520	0.128
Quality management	0.201	0.049
Quality assurance	0.201	0.049
Product compliance	0.078	0.019
Service	0.133	0.133
Customer satisfaction	0.637	0.085
On demand service	0.258	0.034
Claim handling	0.105	0.014
Flexibility	0.116	0.166
Influence on efficiency	0.637	0.074
Readiness for change	0.258	0.030
Influece on compliance	0.105	0.012
Lead time	0.072	0.072
Lead time management	0.564	0.041

Capacity management	0.263	0.019
Production planning & scheduling	0.118	0.008
Influence of design complicacy	0.055	0.004
Supplier performance	0.063	0.063
Transparency & control in the SC	0.637	0.040
Assurance of compliance	0.258	0.016
Supplier management	0.105	0.007
Productivity	0.054	0.054
Production management	0.637	0.034
Dependency on efficiency factors	0.258	0.014
Focused product category	0.105	0.006
Cost	0.043	0.043
Processing cost	0.558	0.024
Management cost	0.249	0.011
Marketibility cost	0.096	0.004
Profitability	0.096	0.004

Appendix 17 Upstream case studies data tables

Table 49. Pair-wise comparison key SC performance factors for downstream cases.

	Cost	Product	Service	Lead-time	Flexibility	Efficiency	Supplier	Sustainability	n-th root	Priority vector
Cost	1.00	0.29	0.51	0.51	0.21	0.51	0.24	0.21	0.376	0.039
Product	3.46	1.00	4.33	4.33	2.11	3.67	3.67	3.00	2.937	0.306
Service	1.96	0.23	1.00	2.11	1.13	3.00	2.33	1.22	1.320	0.138
Lead-time	1.96	0.23	0.47	1.00	0.33	2.33	1.67	1.18	0.869	0.091
Flexibility	4.85	0.47	0.88	3.00	1.00	3.67	3.00	1.22	1.734	0.181
Efficiency	1.96	0.27	0.33	0.43	0.27	1.00	0.56	1.18	0.584	0.061
Supplier	4.09	0.27	0.43	0.60	0.33	1.80	1.00	1.13	0.815	0.085
Sustainability	4.85	0.33	0.82	0.85	0.82	0.85	0.88	1.00	0.954	0.100
Sum	*24.11*	*3.10*	*8.78*	*12.83*	*6.21*	*16.83*	*13.35*	*10.14*	*9.591*	*1.000*
Sum * PV	0.946	0.950	1.209	1.163	1.122	1.025	1.135	1.009	8.560	
Lambda-max	8.560									
CI	0.080									
CR	0.057									

Appendix 18

Table 50. Comparison of sub-factors.

Overall	Upstream	Downstream
Product compliance	Significance of compliant product	Product compliance
Significance of compliant product	Social compliance certification	Influece on compliance
Environmental compliance	Product compliance	Significance of compliant product
Customer satisfaction	Environmental compliance	Environmental compliance
Quality assurance	Quality assurance	Quality yield
Quality yield	Quality management	Readiness for change
Influece on compliance	Customer satisfaction	Customer satisfaction
Readiness for change	Sustainability vs flexibility	Quality assurance
Social compliance certification	Dependency on efficiency factors	Lead time management
Quality management	Quality yield	Transparency & control in the SC

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