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### **An approach to developing agile sustainable supply chains in the fashion industry**

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## **Track 20: Operations, Logistics and Supply Chain Management**

### **An Approach to Developing Agile Sustainable Supply Chains in the Fashion Industry**

With fashion retailers now faced with the simultaneous challenges of achieving supply chain agility and improving sustainability, the aim of this research was to review the literature on agile fashion supply chains and fashion supply chain sustainability in order to better understand how both challenges may be tackled simultaneously. A conceptual model, following a 3- dimensional concurrent engineering logic is presented which proposes that there are multiple enablers of fashion supply chain agility and sustainability that complement each other at the supply chain design, product design and process design levels. It is anticipated that this research will provide fashion retailers with a combined starting point/focus for developing supply chain strategy that is capable of working towards achieving agility and sustainability.

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## **1. Introduction**

The fashion industry is defined by change (Varley et al 2019, Lemieux et al 2012). Demanding consumers expect a wider variety of trend-led products delivered frequently (Moin et al, 2019). These expectations have been heightened by the mediatization of the industry (Rocamora, 2017) and the use of social media to keep up with trends (Nelson et al 2019). Fashion retailers are reconsidering their supply chain strategy (Ferne and Sparks, 2019) with agility considered a winning strategy (Ciarniene and Vienazindiene, 2014). That said, while many retailers struggle (Varley et al 2019) the economic success of certain fashion retailers has prompted major environmental and social concerns (Panigrahi et al 2019). To the best of our knowledge research has not yet considered how agile fashion supply chains can be developed while simultaneously considering also the contemporary critical concept of sustainability. Research has tended to focus on considering the agile and sustainability paradigms separately with researchers such as Cabrita et al (2016) suggesting it is appropriate to integrate this thinking as a means to introduce new business models and supply chains. Additionally, in other industries research now suggests that agile capabilities are necessary conditions for maximizing the outcomes of sustainability practices (Geyi, 2019). Here it is suggested that managers who want to maximize the outcomes of their sustainability initiatives should consider concurrent implementation of sustainability practices and agile practices (Geyi, 2019). Research relating to the fashion industry has not yet explored these ideas.

The remainder of the paper is structured as follows, firstly a brief industry overview is presented followed by a discussion of traditional and contemporary fashion supply chain models. The need for both agility and sustainability in the contemporary fashion supply chain is outlined before the dimensions and enablers of agility are explored. From here, a 3-dimensional concurrent engineering logic has been applied in order to demonstrate where and how there is consensus between the identified enablers of supply chain agility and the enablers of sustainability in the fashion supply chain.

## **2. The fashion Apparel Industry Overview**

The apparel industry has acted as a catalyst of global industrial change, evidenced by the introduction of new models, technologies and relational structures (Oxborrow and Brindley, 2014) and the fashion retail industry as such has shifted dramatically in strategy from product-centric to customer-centric, having a major impact on the responsiveness of fashion retailers (Khan et al 2012; Khan et al 2008). Major changes have occurred in the fashion retail environment (Wen et al, 2019; Parker-Strak et al 2017). The main drivers of change in the late 1980's and 1990's included the rise of the retail brand and vast segmentation of the market, both of which increased due to globalisation (Perry and Wood, 2019). As a result, the global fashion industry has grown substantially, contributing greatly to the economy and the competition in the industry has intensified (Kim, 2013). In the traditional model of retailing, competition was amongst retailers alone (Ferne and Sparks, 2019). However, it is now increasingly realised that although retailers are central to production and consumption (Ferne and Sparks, 2019) it is supply chains that now compete (Gligor et al 2016; Lambert and Cooper 2000; Christopher 2005; Defee and Stank 2005). As an improved supply chain can enhance market and financial performance (Qrunfleh and Tarafdar, 2013), there is a heightened dependence on supply chain management (Wang, 2019; Bruce et al 2004). The

fashion industry, now characterized by high levels of market demand uncertainty and short product life cycles (Kim et al 2013) consists of complex innovative and chaotic systems (Carniene and Vienazindiene, 2014). In such conditions it has been suggested that strategies and structures must be put in place that enable products to be produced on the basis of 'real-time' demand. (Carniene and and Vienazindiene, 2014).

## **2.1 The Traditional Fashion Supply Chain**

The dynamics of the fashion industry have changed with retailers focused on achieving low cost and flexibility in design, quality, and speed to market; all of which are suggested to be key strategies to maintain a profitable position in the increasingly demanding market (Bhardwaj and Fairhurst, 2010). Generally, however, a focus on cost redefined the production strategy of firms with outsourcing becoming a prevalent strategy (Mahmood and Kess, 2016). In the late 1990's production was moved offshore to take advantage of cheaper labour (Londrigan and Jenkins, 2018). As competition in the fashion industry moved from manufacturing to distribution and retailing (Castelli and Brun, 2008), the outsourcing of non-core manufacturing operations increased (Fernie and Wood, 2019). Due to requirements to simultaneously increase production and lower cost, production locations were selected based on labour costs (Londrigan and Jenkins, 2018). In these instances, the traditional fashion supply chain allowed for apparel retailers to forecast consumer demand well in advance of the selling season (Bhardwaj and Fairhurst, 2010). This traditional fashion supply chain however, consists of lengthy, fixed supply procedures preventing many fashion retailers from competing profitably (Wen et al 2018). The product development, production, distribution and sales processes within the fashion industry have, and continue for many retailers, to be a linear and sequential system (Kincade et al 2007; Varley et al 2019). This system starts with forecasting fabrics/colours, ideas are then refined continually throughout lengthy product development and production processes before eventually reaching the final consumer (Kincade et al 2007). For some retailers it has been suggested that only 11 weeks out of the 66 week lead time in the supply chain are used for value added processes; the remaining time sees work in progress or inventories waiting at various stages within the chain (Pal, 2014; Fernie and Sparks, 2019). For other retailer's process time can typically exceed 24 months with contact with consumers often in the final stages of the overall system (if at all) after design and production decisions are made (Kincade et al 2007). It is therefore understandably suggested that traditional apparel supply chains have been too long and inflexible (Carniene and Vienazindienė, 2014). Under these circumstances, responding to changes in demand for large product varieties in short intervals is not possible (Mahmood and Kess, 2016). It is suggested that as the fashion sector has been experiencing slow or even negative growth in some markets due to these failings, further pressure will continue to be placed on suppliers (Fernie and Sparks, 2019).

## **2.2 The Contemporary Fashion Supply Chain**

Fashion retailers are now seeking supply chain solutions that enable them to get innovative product to the right consumer at the right time (Moin et al 2019). To achieve this goal, supply chains have to be agile and flexible with shorter lead times (Moin et al 2019), encouraging brands to explore various possibilities, one of which being onshoring or reshoring production (Londrigan and Jenkins, 2018). They must develop strategies to deal with geographic constraints, establishing strategic relationships to facilitate efficient decision-making

processes (Londrigan and Jenkins, 2018). McKinsey suggest that consolidation of the supplier base, and end to end process efficiency via the digitisation of the entire sourcing process will become a necessity. They emphasise the need for cross functional collaboration, ambitious partnership programmes for greater connectivity and a multi model sourcing model that ensures nearshoring amongst its capabilities (Berg et al 2019).

Fashion retailers, particularly fast fashion retailers, as such compete by ensuring speed to market (Bhardwaj and Fairhurst, 2010) often by shortening the product development process (Berg, et al 2018) and ensuring hybrid roles across the planning and development teams (Boardman et al 2020; Berg, et al 2018). Ultra-fast fashion retailers in particular have adapted the product development process to ensure speed to market (Parker-Strak et al 2020). Parker-Strak et al (2020) suggest a more circular product development process where traditional product development stages are disrupted, and an additional stage added. They highlight the 'studio stage' where products are photographed ready to be launched online as a critical component to the development process and business model of online fast fashion retailers (Parker- Strak et al, 2020). With the suggestion that this stage takes place in parallel to manufacturing (Parker -Strak et al 2020), it is evident that fashion product development for online fast fashion is not aligned to the linear development models of the past. Further research is necessary to establish how fashion retailers across the industry have adapted their product development and supply chain processes to achieve greater levels of agility.

The fashion supply chain continues to be transformed from a manufacturer-push to a demand-led pull system (Fernie and Wood, 2015) where the push for 'faster fashion' has meant that cost has become only one element of the production consideration (Londrigan and Jenkins, 2018). The abilities to meet consumer demand, deliver trend led products and reach the market quicker than the competition have changed priorities in the fashion supply chain (Ciarniene and Vienažindienė, 2014). Today the product development process is data driven with many companies relying on data analytics from systems such as Edited and INstock to facilitate decision making (Boardman et al 2020). The industry also relies not only on data but increasingly on technology throughout the supply chain (Boardman et al 2020; Varely et al 2019). This includes technology that assists in design, digital sampling, body scanning, product lifecycle management and electronic data exchange amongst others (Boardman et al 2020). With customer expectations growing (Khan and Wisner, 2019; Bruce and Daley, 2006) consequently, organisations today are revising their strategic priorities and intentions, now understanding the necessity of supply chain agility (SCA) (Khan and Wisner, 2019).

### **3. Supply Chain Agility and Sustainability**

While successful fashion retailers have understood that their customers are looking for greater variety more frequently than before, hence the need for SCA, and that social media and instant gratification play a huge part in this (Dillon 2018; Londrigan and Jenkins, 2018) they are also under huge pressures to make progress in overcoming the social and environmental concerns that have developed due to the success of 'fast fashion' business models and the throwaway culture that these have created (Wang 2019; Tokatli, 2008). Although social media has facilitated and encouraged greater trend led consumption and has encouraged consumers to become co-creators, the social channels of companies have also become fundamental in spreading sustainability actions (Bruzzo and Abreu, 2019) and have

influenced one of the major consumer trends of today – sustainability (Wang, 2019). Sustainability in fashion is a broad concept but refers to actions including the use of sustainable and renewable materials and processes and social attributes including fair wages and working conditions (Bruzzo and Abreu, 2019). Sustainable supply chain management (SSCM) has started to attract increasing attention from both scholars and practitioners particularly within the context of the fashion industry (eg. Khurana and Richetti, 2016; Ho and Choi, 2012; Sandvik and Stubbs, 2019; Perry and Towers, 2013; Da Giau et al 2015). New research efforts have been developed either considering a single dimension of sustainability or all of the integrated dimensions of sustainability in the supply chain; these dimensions concern the economy, the environment and society and together they are referred to as the triple bottom line (Turker and Altuntas, 2014). Integration of these issues in supply chain research is suggested to be highly valuable as existing literature focus mainly on environmental issues (Turker and Altuntas, 2014). With the fashion industry predicted to grow at 3 to 4 percent in 2020 (McKinsey Global Fashion Index, 2020) trends highlight that while consumers have become favourable towards immediate gratification and convenience, with online shopping fulfilling this need (McKinsey Global Fashion Index), there will continue to be a strong demand for a higher quality of product and greater transparency and sustainability in the supply chain (Wang, 2019). It has also been suggested that in 2020 fashion brands *‘need to swap platitudes and promotional noise for meaningful action and regulatory compliance while facing up to consumer demand for transformational change.... as consumers become increasingly aware of the environmental impact of fashion’* (McKinsey Global Fashion Index, 2020).

While the number of mass market products made from sustainable materials remains low, there has been a five-fold increase over the past two years with successful agile fashion brands continuing to make efforts to increase sustainable options for consumers, potentially working towards making it the new normal in the future (eg. Zara this year pledged to use 100% sustainable fabrics by 2025, H&M committed to using 100% recycled or sustainable materials by 2030 alongside wider sustainability commitments, Adidas committed to phasing out virgin polyester by 2024 and ASOS introduced search filters for sustainable product lines) (McKinsey Global Fashion Index, 2020). Established and international fashion brands such as PUMA, HnM and Marimekko have also all adopted “green” practices in their supply chains (Pal, 2014). Additionally, the social impact of fashion is beginning to be considered more in research (eg. Perry and Wood, 2019) and in industry with a key focus on the social responsibility of relationships with supply chain partners. The ‘Fixing Fashion’ report produced by the House of Commons Environmental Committee suggests that there are many improvements that fashion retailers must make here (House of Commons, Environmental Audit Committee, 2019).

As such, with the need to achieve agility and substantially improve the sustainability of fashion supply chains it is important to consider the enablers of SCA and SSCM in order to understand where there is common ground between these two paradigms. The following sections will outline the dimensions and enablers of SCA outlined within previous research. To follow, a 3-DCE logic will be applied to establish where there is common ground between the enablers of SCA and SSCM.

#### **4. Enabling Supply Chain Agility**

Today fashion retailers attempt to achieve responsiveness via several means; the use of data in the product development process, developing hybrid teams and growing the strategic nature of roles including buying and merchandising, ensuring stronger supplier relationships within dynamic multi-modal sourcing models and adopting technology and digital processes along the supply chain to assist with efficiency, visibility and transparency.

As a dynamic capability, SCA can be a competitive advantage for fashion retailers in an ever-changing industry (Varley et al 2019; Wang, 2016; Gligor et al 2013; Holweg, 2005) characterised by uncertainty (Gligor, 2016). The dynamic capability view (DCV) is suggested to be appropriate in considering the firm's performance in an environment characterized by complexity and uncertainties (Yu et al 2018). Agility is considered a higher order dynamic capability in this sense, through which firms can exploit opportunities while confronting changes in demand, allowing them to develop in the right direction (Irfan et al 2019). It continues therefore, to gain attention in research and practice as a critical dynamic capability to satisfy market needs (Feizabadi et al 2019).

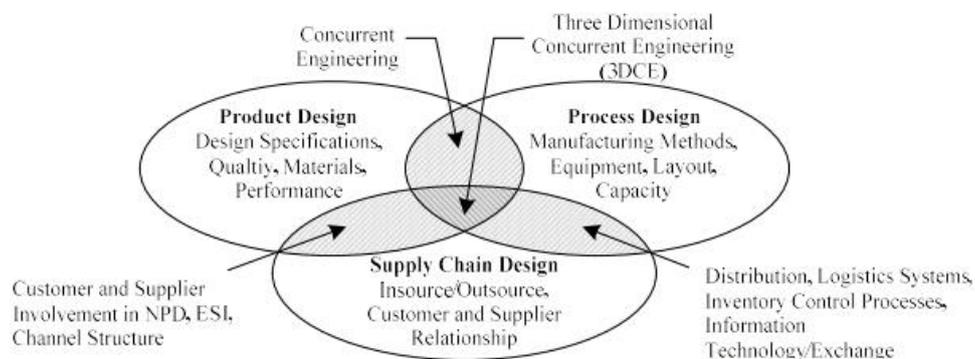
Gligor (2013) presented a classification of supply chain agility in attempt to address the gap relating to the ambiguity surrounding the definition of SCA by conducting a multidisciplinary literature review. They propose five distinct dimensions of SCA, also now adopted by the Council of Supply Chain Management Professionals (CSCMP), including alertness, accessibility, decisiveness, swiftness, and flexibility. It is suggested here that to achieve SCA firms must be able to quickly detect changes (alertness) and access relevant information on how to deal with changes (accessibility), they must then be able to make resolute decisions on how to respond to changes (decisiveness) and be able to quickly implement those decisions (i.e., swiftness). Finally, the firm should be able to modify tactics and operations needed to fulfil demand (i.e., flexibility) (Gligor 2016; Gligor et al., 2013). Gligor (2013) also suggests that these domains of agility can be classified into two distinct categories: physical and cognitive. Alertness, accessibility, and decisiveness exemplify the cognitive dimensions of the concept (relating to information processing and considerations on which actions to take), while swiftness and flexibility represent the physical dimensions of SCA (relating to action taking). Wider literature has suggested that the dimensions of agility are enabled by relationship/partner integration (Feizabadi, et al 2019; Feizabadi et al 2018; Whitten et al, 2010; Harrison et al 1999; Christopher and Towill, 2000; Christopher, 2000; Cerruti et al, 2016; Fayezi and Zommerodi, 2015) and process integration (Harrison et al 1999, Christopher and Towill, 2000; Whitten et al 2010; Christopher, 2000; Xiao, 2014, Irfan et al, 2019; Gligor, 2016); with particular focus on achieving an integrated design process (Khan et al 2012; Khan and Creazza 2009; Choi, 2016; Ismail and Sharifi, 2006) and a disruptive product development process (Parker-Strak et al 2020). Efficiencies are often facilitated by technology integration (Harrison et al, 1999, Wu and Agnelis, 2007; Christopher, 2000; Christopher and Towill, 2000) which influences information integration (Feizabadi et al 2018) meaning the supply chain becomes virtual (Christopher and Towill, 2000) and allows for visibility (Feizabadi et al 2018; Gligor, 2013), market sensitivity (Whitten et al, 2010; Harrison et al 1999) and to be closely connected to end user trends (Agarwal et al 2007).

Having identified the enablers of SCA and why they are necessary, we are now able to consider the enablers of achieving sustainability in the supply chain in order to establish

where there is common ground in relation to the enablers of each concept, thus providing organisations with a combined starting point/focus for achieving both SCA and sustainability. In order to do so, we have mapped the relevant identified enablers of SCA to the 3 three logics outlined within the 3- dimensional concurrent engineering (3-DCE) framework and discuss these in relation to key enablers of sustainability at the supply chain design, product design and process design levels. We have firstly provided a brief overview of the dimensions of 3-DCE and presented the conceptual framework before discussing each dimension (supply chain, product design and process design) separately in relation to the relevant enablers of SCA and sustainability.

### 5.The Dimensions of the 3-DCE Framework

As organisations recognise the strategic nature of supply chain design, it becomes necessary to integrate it with product and process development (Hajikazemi et al 2019). Marche et al (2019) inspired by Meinadier, (2002) suggests that three logics are considered simultaneously. These are the logic of the product, the temporal logic of process (sequence of activities) and the logic of the organisational structure (the supply chain). This echoes the work of Fine (1998) who warned that when firms do not explicitly acknowledge and manage supply chain design and engineering as a concurrent activity to product and process design and engineering, they often encounter problems late in product development. Three-dimensional concurrent engineering (3-DCE), the simultaneous design of product, process and supply chain was as such proposed as a means to improving traditional product development outcomes (Elram et al 2008). Given that achieving sustainability and agility in the supply chain are both heavily reliant on improvements in the product development process, 3-DCE has been considered with regards to improving agility in the supply chain (Marche, 2019) but also with regards to achieving sustainability in the supply chain (Pal, 2014) making it a suitable framework for this research. Additionally, 3-DCE (outlined in figure 1) is an extension of the concurrent engineering concept, whereby it is suggested that products and processes require a concurrent approach to their design and development, involving integrated teams early in the process (Hajikazemi et al 2018).



**Figure 1: 3-Dimensional Concurrent Engineering Framework proposed in Elram et al (2007)**

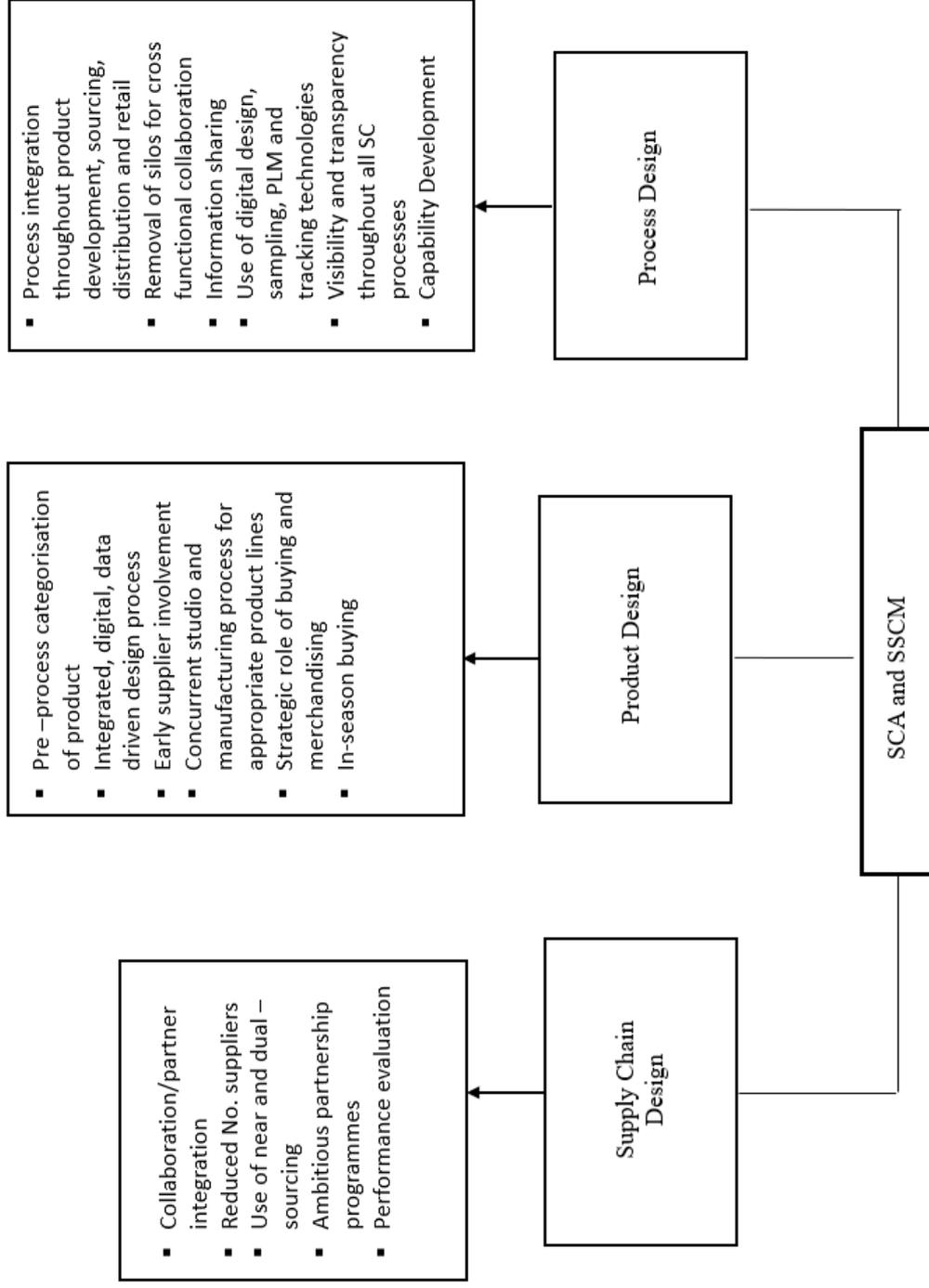
This is supported by Wheelen (2017) in relation to developing sustainable products as she refers to the ‘design and supply chain’ when outlining the combined product and process

concerns for achieving sustainability. 3-DCE is also suggested to be a very useful theoretical lens as researchers have become more concerned with taking a systemic view of the supply chain (Elram et al, 2007).

## **6. Conceptual Framework Development**

The conceptual framework developed for this paper is presented in Figure 2 below. This conceptual framework applies a 3-DCE logic to the development of agility and sustainability in the fashion industry highlighting key priorities at the supply chain design, product design and process design levels. The paper continues by exploring the similarities at each of these levels from both an agility and sustainability perspective. The conceptual framework presented in Figure 2 below suggests that there are multiple complementary enablers of SCA and sustainability at the supply chain design, product design and process design levels. At the supply chain design level important enablers of both SCA and sustainability include collaboration and partner integration. At the product design level an integrated, concurrent design process with early supplier involvement is critical to achieving SCA and sustainability initiatives. Finally, at the process design level enablers of process integration, information integration, digital process development via the use of design and development technologies and cross functional collaboration can be identified as a means of ensuring visibility and enhancing SCA and sustainability efforts. While this research does not attempt to provide an exhaustive list of the enablers of agility and sustainability it does begin to consider where there is common ground between these two paradigms.

**Figure 2: Priorities for enabling SCA and SSCM in Fashion Supply Chains**



The sections to follow individually outline each of the dimensions of 3-DCE and provide a discussion in relation to the similarities in terms of the enablers of SCA and SSCM within each dimension.

## **7. Supply Chain Design**

A sustainable organisation requires ongoing changes in how its supply chain is designed and managed; in alignment with ongoing considerations and improvements in relation to economic, environmental and social initiatives (Fahmimnia et al 2017). Consisting of numerous organisations and functions with often conflicting interests, supply chains are developed and redeveloped depending on emerging business circumstances and opportunities (Sharifi et al 2006). Success relies on an efficient restructuring or redeveloping process (Sharifi et al 2006) where the characteristics of the chain or network are established and put into effect (Sharifi et al 2006). This requires an effective integration of relations (Marche 2019; Fayezi et al., 2017) and processes (Ifran et al., 2019) within the supply chain. Supply chain design (SCD) considers the aspects of sourcing decisions, contracting decisions, make-buy decisions (insourcing or outsourcing) and coordination decisions (Hajikazemi et al., 2019). From a strategic point of view therefore, SCD refers to the process of determining all required actors/components of the supply chain in alignment with current market and customer demands (Ismail and Sharifi, 2006).

### **7.1 Sustainability at the Supply Chain Design Level**

To ensure sustainability in supply chain design, research suggests that fashion retailers should move away from transactional relationships and move towards strategic partnerships based on commitment, trust and continuous improvement (Dubey et al 2017; Hines and McGowan, 2005). A sustainable supply chain at the SC design phase is thus suggested to be enabled by collaboration (Hsueh, 2015; Gimenez et al 2012; Kang et al 2012; Lee, 2010). Suppliers can significantly impact overall value creation including substantially influencing environmental impact (Lu, et al 2018; Handfield and Nichols 2002). Therefore, in order to achieve sustainability goals and initiatives, close attention should be paid to supply practices (Paulraj, 2011). Results presented by Mehdikhani and Valmohammadi (2019) suggest that strategic collaboration in the supply chain is one of the most important factors in achieving sustainability. They suggest that as a majority of companies lack advanced technology and often know-how in terms of reducing the negative effects of supply chain practices, collaboration and knowledge sharing with other partners can allow for more sustainable joint practices to be developed. Research also suggests that the presence of relational or collaborative capabilities can facilitate sustainable supplier management (Paulraj, 2011). The understanding here is that firms with strategic long-term partnerships will be better equipped to develop sustainable supply management practices via interorganisational exchanges. As such, a collaborative strategy is suggested to have the greatest impact on sustainability performance in the supply chain (Orr and Jadhav 2018).

Similarly, the role of collaborative relationships has been further highlighted in the field of sustainable supply chain design with the suggestion that exploring environmental and social responsibilities from an external perspective is critical to ensuring truly sustainable practices within both upstream and downstream functions of a supply chain (Panigrahi et al 2018). Accordingly, developing internal sustainability capabilities should be closely followed by identifying collaborative partners who are monitored and evaluated in terms of meeting sustainability goals. In doing so, it is suggested that firms will be able to capitalize on markets of the future and improve societal relationships while simultaneously enhancing their own reputation (Paulraj, 2011). Karaosman et al (2017) emphasise in their classification framework for sustainability integration in the fashion supply chain that collaboration with partners should be developed alongside supplier evaluation schemes to ensure sustainable development and accountability.

## **7.2 Agility at the Supply Chain Design Level**

The sustainability enabler of collaboration can be closely mapped to that of the partner integration enabler which is proposed for achieving supply chain agility. Cerruti (2016) amongst others suggest that in order to achieve agility a high level of collaboration and integration with suppliers is also considered important (Cerruti, 2016; Christopher, 2000; Gligor and Holcomb, 2012). They also refer to this type of highly involved relationship as a supply partnership and quote Ploetner and Ehrets suggestions that these should be “based on mutual dependency and trust, where both parties are committed to collaboration beyond a sequence of buying-selling transactions” (Ploetner and Ehret, 2006, p. 4). To be responsive the traditional buyer supplier relationship needs to transform into a more collaborative partnership (Fernie and Sparks, 2019; Perry and Wood, 2019). The objective of supplier within these partnerships is to develop the customers business with the benefit of becoming a preferred supplier (Fernie and Sparks, 2019). Academic research suggests that through focusing on collaboration/partner integration retailers can work towards the development of long-term upgraded supplier capabilities by developing stronger working relationships with a smaller number of suppliers (Perry and Wood, 2014). In fashion, many larger retailers are suggested to be reducing the supply base, in order to reduce costs and develop closer partnerships with a fewer number of trusted suppliers (Perry and Wood, 2014; Cerruti, 2016). This is supported by McKinsey who suggest a reduction in terms of the number of suppliers, developing a near and dual sourcing strategy which excels in ambitious partnership programmes for greater connectivity and development (Berg et al 2019). They suggest that companies must now re-map their sourcing mix to achieve both sustainability and agility (Berg et al 2019).

## **8. Product Design**

New product development (NPD) is typically a significant part of any supply chain process (Hajikazemi et al 2018). The product development process is essential to the fashion business (Grose, 2018). In its broadest sense, the term product development describes the development of fashion design ideas into commercial products (Grose 2018). The NPD literature tends to focus on concurrent engineering, early supplier involvement (ESI), understanding customer requirements, and channel structure (Elram et al 2007). Research suggests that successful fashion companies will extend and develop the contribution of design into all aspects of their

business (Khan and Creazza, 2009). A design centric business enables firms to prioritise product design within their supply chains ultimately ensuring integration between product design and the supply chain (Khan and Creazza, 2009). It is well known that the fashion design process is central to successful apparel products, as such it is suggested to be the most fundamental yet critical process in the fashion supply chain (Choi, 2016).

At present there is limited research in the field of Fashion Product Development (FPD) with relatively few theoretical models that support the process (Parker -Strak et al 2017). That said, Parker-Strak et al (2020) have developed a disruptive product development model to illustrate how the product development process is managed within online fast fashion retailers. This model highlights concurrent process and the importance of pre-process categorisation of product. Traditionally the development process begins directly after the design team have broken down initial concepts and trends into theme, colour and fabric stories whereby they can then focus these colour/fabric stories into specific fashion products categories. The designs are then turned into sample garments to be reviewed and often refined (Grose, 2018). Each fashion retailer has its own specific version of the development process which is adapted to its target market and customers (Grose 2018).

### **8.1 Sustainability at the Product Design Level**

There is a growing realisation that the supply chain “begins on the drawing board” meaning that design decisions can dramatically impact the risk profile of the business (Khan and Creazzi, 2009). This suggests that supply chain issues should be considered at the product design and development stage (Khan et al 2012, Cachon and Swinney 2011; Khan and Creazzi, 2009). This highlights the importance of the product design function in designing appropriate supply chain strategies (Khan et al 2012) and aligning design to the supply chain in terms of enhancing competitiveness (Khan and Creazza 2009). Ismail and Sharifi (2006) refer to this as design ‘for’ the supply chain.

Integrating the supplier early in the product design process is important with regards to achieving sustainability initiatives (Orr and Jadhav, 2018). In the fashion industry there are moves being made to introduce new sustainable materials and products into the market (Ksiak, 2016). For example, in discussing H&M, Księżak (2016) suggest that the company is directed towards using certified organic cotton, which lessens the climate impact by 46%. Additionally, they suggest that H&M uses recycled cotton fabric and products that are made from those two kinds of cotton in at least 50% are labelled with a ‘Conscious’ hang tag to make them easily recognisable to customers. It is suggested that by the end of 2020 the company plans to use only this kind of sustainable cotton (Ksiezak, 2016). It is expected therefore, that with new materials and methods being developed, early supplier knowledge and involvement will be required within the planning, design and development stages of fashion supply chains. This is supported in the sustainability research with early supplier involvement in internal processes considered as a key enabler of SSCM (Orr and Jadhav, 2018). In their research Orr and Jadhav (2018) suggest that some of the important differences to normal strategies include the development of externally focussed action plans, much larger contributions from suppliers to initiatives and planning and the development of skills for activities located outside the organisation. They stress the importance of involving the supply chain members in organisational decision making and openness to allowing external partner involvement in internal processes (such as the design process). By incorporating this diverse

knowledge, improvements in sustainability initiatives at the design stage can be made. Further it is suggested here that early supplier involvement in sustainability planning increases engagement within the supply chain which develops and enhances a culture of equal responsibility (Orr and Jadhav, 2018). This sustainability planning is vital at the product design stage as around 30-80% of the environmental impact of a fashion product is suggested to be decided at its design stage, generating nearly 90% of the emitted chemicals (Pal, 2014). This may also further help to address the power imbalance in fashion supply chains. Research suggests that there remains an unequal power base in the relationships present in the fashion supply chain (Oxborrow and Brindley 2014; Hines and McGowan, 2005) which often equates to social sustainability concerns (Perry and Towers, 2014). This organisational change requires businesses to rethink both the processes of managing design, and the ways in which they communicate the strategic value of design to suitable partners (Khan et al 2012). In addition, fashion companies should move towards more sustainable design practices such as virtual product fitting and sampling to reduce waste and create efficiencies (McGregor, 2019). It is also now recommended from an industry perspective that a more seasonless approach to design and trans-seasonal buying would be beneficial (Petro, 2020; Haywood, 2017).

## **8.2 Agility at the Product Design Level**

In the fashion industry new product development is a fast process (Dillon, 2018). The process involves several interactions with designers and product developers/suppliers making revisions where appropriate –often revisions and modifications will take place even after the product has gone into store so as to make alignments in accordance with the demands from the customer (Dillon 2018) thus further highlighting the necessity of early supplier involvement and close supplier relationships. As such, the emerging view of design is that it has a strategic and competitive priority in the supply chain (Khan et al 2012). Alongside the design function the product design phase is being enhanced by the new strategic and hybrid roles of the buying and merchandising functions and their expertise in the management of data and analytics (Boardman et al, 2020). Each of these functions now work in a more hybrid capacity to develop data driven, process efficient product ranges less likely to result in overstock (Berg et al 2020). It has been suggested that early supplier involvement here can be seen as a powerful tool to improve responsiveness of the supply chain (Khan et al 2012).

## **9. Process design**

Process design involves the design of production processes from raw materials to the finished product (Pal, 2014). Attributes of process designing are suggested to include ‘process innovation, identifying and improving process capabilities, higher process engagement and faster rate of process development’ (Pal, 2014). From a supply chain perspective, one of the key elements of a supply chain is represented by the processes of each of the actors that form the chain itself (Marche et al 2019). A process ultimately refers to a set of activities and tasks which are carried out by integrated functions (Marche et al 2019).

### **9.1 Sustainability at the Process Design Level**

From a sustainability point of view one of the key enablers of SSCM at the process level is suggested to be supply chain visibility (Mohanty, 2018). Visibility is facilitated by the integration of technology which has the capacity to ensure that suppliers and customers can

monitor (and thus improve upon) their environmental performance (Mohanty, 2018). Visibility is closely linked to both traceability and transparency in the supply chain (Busse et al 2017). As such this technological integration can also help to ensure transparency which is increasingly central in the sustainable fashion literature (Khurana and Richetti, 2016). Researchers have focused their attention on achieving supply chain visibility as it is suggested to have the potential of improving both operational efficiency and planning capabilities (Caridi et al 2011). Visibility is of major concern in the fashion supply chain with retailers often having low supply chain visibility and little knowledge about indirect suppliers (Busse et al 2017). This lack of visibility is suggested to create significant gaps in knowledge and control enhancing sustainability risks (Busse et al 2017). Technologies have been developed to improve visibility and efficiency along the supply chain such as radio frequency identification (RFID) (Caridi et al 2011) and product lifecycle management (PLM) software. Finding ways to extract, collect, and share information between different parties and within different processes of an integrated supply chain may therefore facilitate greater supply chain visibility and better identification and assessment of sustainability risks (Busse et al 2017). Karaosman et al (2017) noted with regards to information sharing in the fashion supply chain that more advanced communication is required with processes needed to support know-how sharing and supplier development. That said, although there have been suggestions made to further digitalise the product development, sourcing, distribution and retail processes, these changes may be challenging to implement for a number of reasons including cost, process change, mindset issues and lack of willingness to share information. It has also been suggested that projects focused on improving traceability in the fashion supply chain are limited due to a lack of end to end visibility (Karaosman et al 2018). To improve here, focus must shift from simply reducing the negative effects of current practices, to an approach where effort is expended on devising new strategies and processes capable of addressing end to end visibility and sustainability throughout the supply chain (Karaosman et al 2018).

## **9.2 Agility at the Process Design Level**

By ensuring effective coordination and integration of processes and information along the supply chain firms are also able to achieve the level of innovation and flexibility necessary for agility (Caridi et al 2011). Information sharing between different supply chain stages to increase supply chain visibility can also be identified as a critical enabler of SCA. This does however remain a huge supply chain challenge as the amount of information and data generated continues to increase (Kache and Suering, 2017). The challenge here is to identify and extract the most relevant information (Kache and Suering, 2017). As such, the use of technologies and data such as PLM, digital sampling tools, RFID and data analytics amongst others can be implemented to facilitate this (Kabukcu, 2017; Wu and Angelis, 2017). This allows for market sensitivity to demand changes from the marketplace but does depend on how quickly and accurately channel firms can read and capture sales data (Moon et al 2017). To achieve this level of sensitivity process integration, ie the extent to which a firm can design, streamline and execute its supply chain processes is necessary (Ifraan et al 2019). Process integration to this extent critically aligns key activities and strengthens the buyer–supplier relationship (Ifraan et al 2019) and is identified as a central concept in agile supply chain practice (Spragg, 2012) particularly at the product development and sourcing stages (Berg et al 2019). Agility like sustainability is therefore also enabled via an end-to-end

perspective requiring a move away from working in functional “silos” (Khan et al, 2012) and a move towards process integration, information sharing and the use of design and development technologies to ensure visibility including 3D design, virtual sampling and video sign offs (Berg et al 2020).

## **10. Conclusions**

As the fashion industry continues to develop, there is a need across the industry to develop both agile and sustainable supply chain practices that can work together simultaneously. With fast fashion generally associated with an agile supply chain and slow fashion generally associated more with a sustainable supply chain this research sought to consider the possibility that agile supply chain capabilities are necessary for the development of sustainable supply chains. At the product design, process, design and supply chain design levels, this research attempts to highlight how dynamic agile capabilities can and should inform the development of sustainable supply chains. While the paradigms do have differences eg. the necessary use of sustainable materials, there are enablers similar to both paradigms. The development of strong supplier partnerships for example is a critical component of both supply chain agility and sustainable supply chain management. Given the need for fashion retailers across the industry to begin embracing the challenges of achieving supply chain agility and sustainability, this research attempts to address a core set of interrelated enablers to be prioritised for achieving supply chain agility and sustainability. These include developments in product development including pre –process categorisation of product, an integrated, digital, data driven design process, early supplier involvement, concurrent process stages and seasonless design principles/trans-seasonal buying for appropriate product lines and strategic developments of the roles of buying and merchandising professionals. It is also recommended that to achieve both sustainability and agility that fashion retailers work with fewer suppliers, adopting dual and nearshoring where necessary. A critical enabler of both agility and sustainability is the development of integrated processes, this includes at the design, sourcing, distribution and retail phases of the supply chain, likely to be facilitated by the removal of functional silos and the adoption of digital design, sampling, development and tracking software to ensure information sharing, visibility and transparency across the supply chain.

It is suggested that future research should focus more on considering how agile capabilities in the fashion industry can be developed to enhance sustainability. It is important from a fashion industry perspective to understand how agile capabilities impact on sustainability initiatives as other industries have begun to establish that agile capabilities are necessary conditions for maximizing the outcomes of sustainability practices. It may be the case, as in other industries, that managers who want to maximize the outcomes of their sustainability initiatives should consider concurrent implementation of sustainability practices and agile practices. Secondly, it is important to consider the factors that affect individual enablers of supply chain agility and sustainability such as partner and process integration and how these factors affect the firm’s ability to achieve agility and sustainability. Finally, with regards to future research,

further efforts are required that focus specifically on the fashion development and sourcing processes as a means to achieving agility and sustainability in the fashion supply chain. Research is needed that explores a variety of different fashion retailers and how their strategies for achieving agility and sustainability differ.

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