

Managing sustainability in the fashion business: Challenges in product development for clothing longevity in the UK
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1 Introduction

Decisions made during new product development (NPD) processes can significantly affect the extent to which products are sustainable and product longevity is amongst the numerous sustainability issues which can play a part in minimising environmental sustainability impacts (Fletcher, 2007; Cooper, 2010). Clothing is the largest non-food product sector in the UK in financial terms (ONS, 2018) and is consequently responsible for major sustainability impacts on society and the environment. Sustainability is thus an important issue for the industry as the production and processing phases of the clothing life cycle are creating increasing environmental impacts due to a rise in the amount of clothing being purchased (WRAP, 2017; Mintel, 2017). Post-purchase clothing care and maintenance also has a detrimental impact on the environment (Allwood et al., 2008) and the product development stage can affect garments' sustainability performance during usage and disposal.

Fashion (which we consider to mean styles that follow prevailing trends) forms a major component of the clothing sector, since six of the top 10 clothing retailers in the UK by turnover, sell predominantly fashion-orientated ranges (Mintel, 2017). More specifically, fast fashion, i.e. garments in contemporary styles, which are designed and produced within a relatively short timescale (Barnes and Lea-Greenwood, 2010), clearly thrives on frequently changing trends and consequent obsolescence, thus appearing to be incompatible with the notion of keeping clothes for an extended period of time. Fast fashion, therefore, creates a relatively high proportion of sustainability problems, within the overall clothing sector, such

as textile waste management, as a result of excessive usage and disposal of valuable natural resources (Achabou and Dekhili, 2013; Ekström, 2015). The problems inherent in the prevailing fast fashion system and an increasing awareness of its negative sustainability impacts, have encouraged the development of the 'slow fashion' movement, which respects resources and slows down the rate at which we consume them (Ozdamar Ertekin and Atik, 2015). Fuelled by 'ethical consumerism' which has created demand from consumers for more sustainable goods, slow fashion considers various stakeholder needs, prioritising quality over quantity with a maximum of four collections per year as a more sustainable alternative (Fletcher, 2007; Cataldi, 2013; Pookulangara and Shephard, 2013; Minney, 2016; Henninger and Singh, 2017). This contradictory situation is explored within our article, through insights from key stakeholders (clothing retailers, brands and manufacturers) about clothing longevity, which is a component of the slow fashion system.

Defining the boundary between clothing and fashion is problematic, since they essentially exist on a continuum between functional and aesthetic priorities; we have therefore chosen to refer to the clothing sector in this article as it is more clearly defined and has a larger scale impact on the environment, since it comprises all garment types. Previous academic research into extending product lifetimes in the context of supply chains is extremely sparse, although government-funded reports have addressed the topic and a requirement has been identified for more in-depth research into clothing longevity, as well as behaviour relating to maintenance and disposal of garments (WRAP 2015).

It is an important area to investigate because life cycle assessment (LCA) has found that extending garments' active life via design, maintenance and re-use of clothing is the most effective method of reducing the impact of the clothing industry on the environment (WRAP, 2012).

Our study demonstrates the potentially conflicting tensions that can exist between sustainable practices and commerciality, raising the issue of agency, or lack of it, in addressing and scaling this design and commercial challenge. It explores the roles of product development teams and the drivers and challenges facing those involved in the commercial, design and usage aspects of reducing the environmental impact of clothing. Ultimately, this

study examines whether traditional structures and norms within the clothing industry constrain the agency of fashion designers to promote sustainable design by engaging in the development of longer lasting clothing.

This research reported in this paper aims to identify and understand the knowledge, skills, processes and infrastructure that could support wider adoption of design for longevity in the clothing industry by exploring the obstacles to implementing innovative and sustainable product development in relation to NPD theoretical frameworks. This article addresses three key research questions based on the analysis of the clothing industry interviews which formed part of a larger study that also addressed other stakeholders. Firstly, what are the major issues in managing sustainability and longevity in clothing product development? Secondly, what are the key challenges in fashion product development to prolong clothing lifetimes? Finally, how can these challenges be addressed via knowledge, skills, process and infrastructure to enable fashion product developers to enhance clothing longevity? Its key contribution is to link NPD theory to product longevity in practice, bringing together managerial, technical and design perspectives and thus providing product developers with the capacity to reduce the environmental impacts of clothing .

This study formed part of a wider research project undertaken for Defra (Cooper et al., *in press*), aimed at understanding industry, expert and consumer views pertaining to clothing longevity as a vehicle for reducing the negative impact of fashion on the environment. The research was conducted by an interdisciplinary team with expertise in marketing, design, product development and supply chain management, reflecting the breadth of expertise concerned with sustainability in fashion management. The project report will be supplemented with a toolkit, the *Clothing Durability Dozen*, aimed at enabling clothing companies to identify what they are currently doing to make clothes last longer, identify any gaps in skills and knowledge, and develop approaches to clothing durability tailored to their requirements.

2 Challenges in New Product Development and environmental sustainability

This section raises challenging issues relating to sustainability in the context of NPD. Since NPD comprises the stages prior to bulk manufacture of products, decisions made by product developers have the potential to guide manufacturing and the subsequent usage and divestment of products by customers towards a sustainable direction. The 'triple bottom-line' concept has become renowned for addressing the importance for organisations of taking into account social and environmental sustainability alongside financial sustainability, (Elkington, 1999). Corporate Social Responsibility (CSR) policies have become standard practice for organisations in recent years, to address social and environmental issues whilst retaining the financial sustainability required to succeed in business, and the NPD process is a crucial area for the implementation of CSR (Goworek, 2011).

2.1 Applying sustainability issues to NPD process models

Traditional NPD models are often based on linear stage-gate models, involving gates through which each product must pass before progressing to the next stage of development. Such models focus on cross-disciplinary processes, rather than being based upon separate company functions. The classic, widely cited NPD process model, comprising idea generation; idea screening; concept testing and business analysis through to product development, test marketing; commercialisation; monitoring and evaluation (Trott, 2017), has relevance to the systems that operate within many industries. Although the terminology used for NPD stages in the clothing industry can differ from this model, the broad principles remain the same. Another popular variation, Cooper and Edgett's (2008) stage-gate NPD model, is summarized into five steps, beginning with scoping and business analysis stages that lend themselves well to the incorporation of sustainability considerations, before development, testing and validation, and then launch. The Strategic Opportunity Product Development model develops this concept further, as a modified stage-gate process that inserts a market analysis stage prior to the initial scoping/ideas stage, to focus on consumer needs and competitors' offerings, thus aiming to develop different ideas from the competition by incorporating the voice of the customer (Pitta and Pitta, 2012) from the outset.

NPD teams often underestimate the time required at each stage, since critical paths require advance planning, and Oorschott et al., (2017) propose a more flexible approach to timing,

with the possibility of taking certain delayed tasks forward after a stage has been signed off by management. Additionally, these stage-gate models do not directly address issues of sustainability. For NPD projects in companies that have little prior experience of addressing environmental sustainability, it may be particularly difficult to assess time-planning effectively. It could therefore be preferable to use the recommended flexible approach to planning the timescale of each stage in the process for sustainable NPD, at least until the firm's NPD teams gain more knowledge in this respect. For example, NPD teams may require extra collaboration time to address the dilemma of selecting sustainable materials, as there can often be a trade-off between social and environmental sustainability (Luchs et al., 2012), with different materials and components having different impacts at value-adding stages, e.g. a Fair Trade product from India could be more highly rated in social sustainability terms but it would create a higher carbon footprint than a locally-produced product at the distribution stage. There is the potential for firms to be encouraged to incorporate improved sustainability techniques when updating their NPD processes.

2.2 NPD and Sustainable Supply Chain Management

Since NPD processes involve preparation of concepts for their practical implementation in bulk production, it is pertinent to consider connections between NPD and sustainability within the supply chain. This study follows Carter and Rogers' (2008: 368) definition of Sustainable Supply Chain Management (SSCM) as "the strategic, transparent integration and achievement of an organisation's environmental, social, and economic goals in the systematic co-ordination of key inter-organisational business processes for improving the long-term economic performance of the individual company and its chains." Key aspects of implementing this process include supplier development, greater cross-functional co-operation, consumer and retailer buying pressure, legislation, and senior management buy-in (Sharma et al. 2010; Seuring and Muller, 2008), all of which can also relate directly to NPD.

A related concept, Green Supply Chain Management (GrSCM) is defined as: "integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life" (Srivastava

2007:54-5). Choi and Hwang (2015) stress the importance of eco-design and investment recovery by maximising the value recovered from end-of-life waste products. Eco-design, which includes managing the life-expectancy of products, is reputation-enhancing and can encourage some consumers to pay more (ibid). Perhaps not surprisingly, therefore, Choi and Hwang (2015) found that these GSCM practices raise capabilities and lead to environmental as well as financial improvements, especially where there were high levels of collaboration throughout the supply chain, since eco-design depends upon collaboration for its implementation, while collaborative capabilities enabled firms to leverage suppliers' knowledge and resources. Furthermore, NPD for clothing brands or retailers can often be conducted collaboratively with product developers employed by their suppliers, and such collaboration can help customers to leverage synergies from their suppliers, and enhance or improve the environmental integrity of their materials (Thabrew et al., 2009).

3 Challenges in Sustainable New Product Development in the clothing sector

Sustainability is becoming an increasingly important challenge in the clothing sector, particularly for fast fashion, which impacts upon both environmental and social sustainability, producing a high level of waste (Rutter et al., 2017), with the former being the focus of this paper. Research also elucidates crucial environmental issues within sustainability discourses (Sikdar, 2004; Mariadoss et al., 2016). The usage of organic cotton has become a default option for clothing firms wishing to demonstrate that they care about environmental sustainability (McNeill and Moore, 2015) and has also been a popular aspect of research into environmentally sustainable fashion (for example, Weller, 2013; Bucklow et al., 2017). However, all phases of the clothing life cycle, from production to usage and disposal, can create negative effects upon the environment and need to be addressed; for example clothing longevity, which impacts upon the latter end of a garment's lifecycle, can be heavily influenced in the early stages of NPD. Allwood et al. (2008) conclude that, for some clothing items, the environmental impact of clothing is greater from use and maintenance than from the materials and production stages, and that modifications made at the design stage should reflect this. However, the WRAP report (2012) found that most carbon, water and waste footprint impacts are embedded in clothing production, rather

than its use and care, and concluded that extending average clothing lifetime by one third could reduce its environmental footprint by over 20% (ibid). Pre- and post-consumer waste issues across the clothing industry are prevalent, with companies seeking to address this in a variety of ways such as clothing take-back schemes, using recycled ocean plastic to create new yarns, using surplus fabrics, re-fashioning discarded garments and raising consumer awareness (Ekström, 2015; Binotto and Payne, 2017). Textile waste, including used clothing, is often not prioritised by local councils for recycling and a lack of convenience can consequently lead to unsustainable landfill disposal, rather than extending clothing's lifetime by reusing potentially valuable textile fibres within the supply chain, thereby contributing to the circular economy (Weber et al., 2017).

As all phases of the clothing life cycle, from production to usage and disposal, can create negative effects upon the environment, we have chosen to highlight the less well-documented but significant sustainability issue of clothing longevity. Extending the average life of clothes by three months' usage per item could reduce carbon, water and waste footprints by 5-10%, thus potentially leading to savings for producers and consumers (WRAP, 2012), and this can be addressed / heavily influenced in the early stages of NPD.

3.1 The sustainable clothing market

The terms 'ethical' and 'sustainable' clothing are often used interchangeably in the literature, amongst other terms such as 'eco' and 'green' (Cervellon and Wernerfelt, 2012; Lundblad and Davies, 2016). We have chosen to refer to 'sustainable clothing' in this study as it was the most popular term in the literature, it was widely used and recognised by the clothing companies in our research and it is more relevant to environmental sustainability, with which clothing longevity is strongly connected. 'Clothing' was selected in preference to 'fashion', since clothing is more specific and can be applied equally to men's, women's and children's wear. Our study relates particularly to sustainable clothing, which is designed to minimise detrimental impact on the environment.

Former perceptions that sustainable clothing is unfashionable (Tomolillo and Shaw, 2003) have been quashed in recent years, with growing awareness of 'slow fashion' (Ozdamar

Ertekin and Atik, 2015; Minney, 2016) and the launch of fashion exhibitions featuring sustainable clothing at international Fashion Weeks. Additionally, a wider selection of sustainable clothing has become available on the UK market during the last decade (Lundblad and Davies, 2016) and 'The Future Fabrics Expo' launched in 2011 as a platform to enable product developers to access more sustainable textiles (The Sustainable Angle, 2018) reflecting the increasing demand for, and production of, sustainable clothing. It is becoming increasingly popular to incorporate sustainable features into clothing ranges for both established names at various market levels, such as Marks & Spencer, H&M and Vivienne Westwood, or for specialist sustainable clothing collections, including People Tree and Linda Loudermilk. Such developments indicate more widespread acceptance of sustainable clothing internationally,

3.2 NPD and Sustainable Supply Chain Management in the Clothing Sector

Multi-disciplinary co-operation between actors across the product lifecycle (design and production teams, buyers and suppliers, marketing and corporate responsibility managers) helps achieve customer value and sustainable design (Curwen et al., 2012). In turn, company ethos, systems-thinking (Hong, 2009) and a proactive business culture support sustainable design objectives, structure and processes (Curwen et al. 2012). The integration of suppliers and cross-functional teams can collectively address principles of design for sustainable clothing - outlined by Curwen et al. (2012) as company mandate, core values match, gathering and diffusing information, cross-functional organisation and significance of the supply chain. In turn, adopting this multi-disciplinary approach can help to optimise use of materials, design and consumption (Gam et al., 2008). Since previous research has shown that impediments to communication can arise in cross-functional NPD teams due to differences in terminology used by different job roles, it is useful for team members with cross-functional knowledge to be recruited to NPD projects (Park et al., 2009). Sustainability also has its own terminology, and NPD team members may therefore require education in these additional terms in order to deal effectively with sustainability aspects of the products with which they are dealing and to create a common language that facilitates communication between clothing brands or retailers and their suppliers.

In the fast fashion industry, which is notoriously environmentally challenging, Turker and Altuntas (2014) found that downstream participants pay considerable attention to monitoring sustainability activities throughout their supply chains, and imposing sustainability criteria upstream. However, Li et al. (2014) propose that collaboration should be enhanced further if companies are to achieve effective governance of supply chain sustainability throughout their supply chains. Sharma et al. (2010) argue that a Build-To-Order (BTO) strategy can reduce unsustainable surplus supply, but requires changes in internal processes, with information sharing and local supply becoming key contributors to reducing environmental impact. This argument can be applied to clothing production generally, and fast fashion in particular since, in fast fashion, speed and flexibility are considered to reduce inventory while local sourcing reduces fuel and emissions (Choi and Hwang, 2015). However, Choi and Hwang (ibid) suggest that this view constrains the appetite to implement further environmental improvements and question whether the practice can overcome the negative impact of over-consumption. Solutions drawn from generic supply chain management practices can be turned into implementation strategies that avoid over-supply. Ismail and Sharifi (2006) advocate that the design of the supply chain network and practices should be concurrent with product and process design, so it follows that adopting this approach would imply that the introduction of sustainable supply chain objectives needs to be an integrated and planned process, not one that is bolted onto existing supply chain practice.

3.3 Agency of fashion designers and governance in sustainable NPD

Sustainable fashion design literature proposes that designers are appropriately informed and able to influence the product development process (Fletcher, 2007; Gwilt and Rissanen, 2010; Fletcher and Grose, 2012; Ræbild and Bang, 2017). However, Palomo-Lovinski and Hahn (2014) suggest that designers working for mainstream fashion businesses lack the empowerment and awareness or knowledge required to influence the process to any extent. According to Barker (2005:448), agency or the “capacity of individuals to act independently and make their own choices” is influenced and limited by increasingly global, isomorphic governance structures, in which agents interact through established ‘norms’ (Giddens, 1986) and globalisation is the accepted norm for many organisations in the clothing industry (Spicer, 2006). To achieve sustainable product management and realise

more sustainable outcomes, research suggests that firms need to evolve their governance structures. This might entail rethinking the balance between short-term profit and longer term gain (Lozano et al., 2015), exploring alternative views on how value is added and shared (Lockett et al., 2011), securing top management support and developing trust in buyer-supplier relationships (Hoejmose et al., 2012). In turn, this would enable firms to adopt alternative approaches to their product-service mix and end-of-life offers (Lockett et al., 2011) but requires a clearer understanding by product developers of the use phase (Taylor, 2013). These generic strategies are consistent with specific proposals to reduce the negative impacts of fast fashion (Choi and Hwang, 2015; Li et al., 2014; Sharma et al., 2010), which demonstrates their potential applicability to the sustainable clothing supply chain context.

In sustainable fashion, the 'agency of design' is discussed in product development (Farrer, 2010:22), although the multi-disciplinary nature of the commercial design process is often overlooked. Providing fashion designers with agency and knowledge about relevant aspects of sustainability within an organisational context could thus facilitate the development of more sustainable products. However, designers are not exclusively responsible for the sustainability of fashion products and other key business functions, including garment technology, buying, purchasing, merchandising and marketing also have significant parts to play. For example, Peattie and Peattie (2008) recognise that marketers can also affect consumption reduction and, in order to facilitate this, existing models require adaptation.

The shared aesthetic, sustainability and commercial 'values' in and between companies reflect the technical objectives of the NPD process and the opportunity to meet sustainable values, as well as the commercial priorities of cost, quality and fashion in addition to emotional aspects that generate customer loyalty (Laitala and Klepp, 2011; Niinimäki, 2012). Indeed, emotional durability can be as significant as physical durability when designing for clothing longevity, since serviceable goods may be discarded if there is no emotional attachment (Cramer, 2011), and fashion designers and their colleagues should take this into account during NPD. Reuse of clothing takes place, of course, but supply exceeds demand and many wearable items end up in landfill. Good quality is usually prioritised as an intrinsic feature of luxury fashion (Achabou and Dekhili, 2013) and ready-to-wear fashion designers

therefore have more capacity to design durability into garments, with fewer cost constraints than exist in mass-market brands. Indeed, luxury fashion garments are sometimes referred to as investments, suggesting that they have a high level of value that may encourage their owners to keep them for longer, or which facilitates retained value when they are discarded and may avoid disposal to landfill.

To reflect these diverse influences, this paper explores NPD-related theories (Gam et al., 2008; Curwen et al., 2012; Trott, 2015), to establish the most apt for our study into sustainable clothing NPD. Stage-gate NPD models provided suitable, practice-orientated conceptual frameworks for research in this field. However, a set of principles for sustainable design adopted by Curwen et al. (2012) was considered the most directly relevant as it applied specifically to the clothing sector, and considered elements of governance and supply chain collaboration. Their principles represent the desirable contribution and multiple influences of the various roles, key players and cross-functional teams within the supply chain through which to analyse the factors at work when developing sustainable clothing. However, the principles, and subsequent recommendations were based upon a single case study – Eileen Fisher, a US-based ethical clothing brand - and related to the trial implementation of a specific sustainable fashion project. This provides the opportunity to explore how well this approach can be transferred to a wider, mainstream fashion context in the UK, and whether it can be applied at scale.

The challenges experienced by the Eileen Fisher Company, and the proposed solutions were consolidated into five key principles, as discussed in section 3.2 (Curwen et al., 2012, p40; 42-43). ‘Company mandate’ reflects the requirement for new approaches to governance and agency (Bostrom et al., 2015; Hojmosse et al. 2012; Lozano et al., 2015). ‘Core values match’ involves the setting of strategic goals to balance the priorities of cost, aesthetics, time and sustainability (Cooper et al., 2013; Kumar and Noble, 2016; Lozano et al., 2015). ‘Knowledge sharing’ sums up the need for designers and other internal and external agents to understand the consumer and product contexts (Fletcher 2007; Fletcher and Grose 2012; Gwilt and Rissanen 2010). ‘Cross functional organisation’ reflects the need for change within and between the multiple stakeholders (Gam et al., 2008) within the organisation, while, finally, ‘significance of the supply chain’ reflects the role of upstream and downstream

organisations and the relationships between them (Caniato et al., 2012; Jean et al., 2017; Wu et al., 2010). For Eileen Fisher, the company mandate and managing relations with suppliers were important in seeing the project through to completion, whereas compromises across the range of values, the sharing of knowledge and multi-disciplinary collaboration were key to its success.

4 Perspectives on stakeholders in clothing longevity

Product longevity encompasses physical durability, consumer behaviour and wider socio-cultural influences (Cooper, 2010) and it is therefore pertinent to consider perspectives of key stakeholders, including manufacturers, retailers, consumers and government. The term 'longevity' has been adopted for this study because it refers to a product's total life-span, moving beyond design and manufacture to socio-cultural influences and user behaviour. Reuse is common and faulty used garments that cannot be repaired can acquire further longevity if they are repurposed for another function or redesigned. Extending clothing lifetimes via more sustainable NPD, usage and re-use can help to reduce their impact on the environment.

4.1 Perspectives on manufacturers and retailers

Sustainable design through clothing longevity appears at odds with the cost and time priorities of the prevailing fashion business model (Cooper et al., 2013) in which only small firms have been able to do more than adopt incremental product and process improvements, and have reshaped their whole supply chain (Caniato et al., 2012). However, while developing longer-lasting clothing is technically achievable (WRAP, 2014), many businesses have so far failed to adopt this strategy, possibly regarding the commercial case for doing so as unproven, with fast turnaround of styles and short-term fashions the prevailing model. Yet one third of the UK population say they would buy clothing 'made to last' longer (Langley et al., 2013) and others are increasingly value-conscious, with a recent forecast of limited spending growth on clothing in the UK (Intel, 2017), thus increasing the opportunity for longer lasting classic items and improved recycling and re-use schemes (WRAP, 2012). A range of approaches can be adopted by brands and retailers' NPD teams to improve product longevity, for example, by developing styles which are innovative yet do not simply aim to follow High Street fashion trends (Goworek et al., 2012). From our

previous research for WRAP (Cooper et al., 2013; Cooper et al., 2014), which addressed technical issues concerning the production of longer lasting clothing, it became apparent that obstacles in the supply chain and NPD process are systemic. The focus of this paper is, therefore, to explore the reasons for these pervasive difficulties, while recognising that the longer term challenge of developing new business models also needs to be resolved.

Sustainable approaches to NPD could offer companies new opportunities. Kim and Mauborgne (2009) encourage firms and their product developers to devise ideas that compete across markets, rather than competing within specific market spaces, by looking across the following 'Six Paths' within which competition is constrained. Firstly, organisations are encouraged to consider operating in alternative industries, then to look across strategic groups within industry. Kim and Mauborgne (ibid.) recommend considering strategic groups of customers and buyers next. Extending the scope of products and services is a particularly significant path within this framework that clothing companies can follow, moving beyond their existing offer to meet customer needs with sustainable products. Organisations can also rethink the functional-emotional orientation of an industry, which applies effectively to clothing with its combination of function and emotional attachment. Time is the final, highly relevant boundary in the Six Paths framework, referring to influencing trends over time, which is pertinent to aspects of slow fashion such as clothing longevity. This framework can be applied effectively to firms to seek out new opportunities in less cluttered markets. For example, Pitta and Pitta (2012) apply it to the start of their Strategic Opportunity NPD model when presenting the case of Clothing Vault, a US-based retailer that sought to move out of a crowded fashion market into a new, less occupied space by retaining its product type but changing the scope of its offer to include clothing sharing, reflecting the informal practice of its customers with limited budgets. The last two paths, in particular, could align with the concept (and practice) of enhancing clothing lifetimes by encompassing both emotional and temporal durability within NPD. Maintaining longer active use of clothing requires a pro-active, visionary design approach (Laitala and Klepp, 2011; Niinimäki, 2012) to maximise emotional durability. Clothing companies could blame their reluctance to offer more sustainable clothing ranges on a lack of consumer demand, yet the move towards an environmentally sustainable industry is an iterative process, shared between clothing retailers, their suppliers and consumers.

4.2 Perspectives on consumers

Consumer demand for sustainable clothing is rising and Mintel (2017) found that most consumers would prefer fashion brands to be more environmentally friendly, particularly those aged 16-24, who are more likely to have been educated about climate change and its potential impacts upon their generation. Song and Ko (2017) identified two key segments of potential customers for such clothing when they categorised a sample of South Korean students (the majority aged in their 20s) according to their sustainable fashion consumption behaviour: 'Doubtful Egoists' and 'Single-minded Bystanders', who focus on durability more than other sustainability issues, to prolong wearability. Similarly, research in Sweden identified consumers, mainly born between 1930-1945, who focus on durability by purchasing classic, quality garments (Ekström, 2015). In the UK, a WRAP survey found that younger respondents, more affluent households, and women reported longevity as desirable, and over half of participants indicated they would do more to buy longer lasting clothes, although not necessarily equating this with environmental considerations (Langley et al., 2013). These studies demonstrate that there are customers in different age groups and markets who consider durability, in connection with quality, when making fashion purchases, even if sustainability is not their main motivation. The majority of research into clothing maintenance and care focuses on the environmental impact of energy, water and chemical usage, and information is lacking about consumer attitudes, behaviours, and understanding of maintenance processes. Research has shown that there is a desire to keep clothes looking good for longer through better informed approaches to care and maintenance (Langley et al., 2013; Laitala and Boks, 2012). This suggests that NPD for extending clothing lifetimes should also take into account how more durable clothing items can be cared for sustainably by consumers, for example by avoiding dry-clean only fabrics.

The whole consumer decision-making process, from recognition of a need through to divestment should be considered when developing more sustainable products, incorporating both the earlier, evaluation stage and the subsequent post-purchase phase that eventually leads to product disposal (Song and Ko, 2017). An advantage of extending the average life of clothes by three months' usage per item is that it could reduce carbon, water and waste footprints by 5-10%, thus potentially leading to savings for producers and

consumers (WRAP, 2012), and if consumers can be encouraged to keep clothes for longer than this, environmental footprints will be reduced accordingly. Fewer resources could be consumed during production if the usable life of garments were to be increased, thus requiring lower replacement frequency and less need to discard clothing (Cooper et al., 2013). Another method for consumers to minimise the harm that their clothing does to the environment would be to reduce the number of new garments that they purchase (Ruppert-Stroescu et al., 2015).

4.3 Perspectives on government intervention

Improving clothing longevity has been considered a policy objective in the UK (Defra, 2011) to minimise unsustainable product disposal such as the excessive numbers of garments discarded in landfill sites, based on the assumption that new business models could address the potential for negative commercial impacts (WRAP, 2012; Defra, 2017). However, the industry has thus far resisted widespread adoption of techniques to extend clothing lifetimes. Governments could potentially improve this situation by developing regulations for textile products to encourage a circular economy in this sector. Manufacturers of electrical goods have already become responsible for the disposal of their products in the US, under Extended Producer Responsibility (EPR) legislation, and in the EU via the Waste Electrical and Electronic Equipment (WEEE) Directive (Pangburn and Stavroulaki, 2014). Government policy could also be developed to encourage a cradle-to-cradle approach to clothing lifecycles (Henry et al., 2015; McDonough and Braungart, 2008), by creating guidelines, legislation and infrastructure to enable manufacturers to move away from the standard cradle-to-grave approach.

In reviewing the literature we have identified a requirement for further research focusing on NPD environmentally sustainable clothing, recognising a particular gap for studies on clothing longevity which connect theory with practice.

5 Methodology

This research reported in this paper was based on a qualitative research approach, built upon previous funded projects that explored current industry processes and behaviours in

relation to NPD and the supply chain, in the context of design for clothing longevity¹. The qualitative approach enabled researchers to explore the subject in detail by understanding actors' behaviour and interactions (Daniels and Cannice, 2004) and capturing the voice of participants (Lincoln and Guba, 2011). Discussing the knowledge gained through participants' lived experience secured depth, rather than generalisability, and reliability was secured from exposure to multiple views (ibid). Semi-structured interviews were undertaken with 31 clothing industry stakeholders from 21 companies in fashion retail and the supply chain, using a sample of participants from relevant sub-segments within the sector (Boddy, 2016), including knitted and woven fashions, and different roles throughout the supply chain. The sample comprised experienced industry professionals in various technical and managerial roles from six upstream suppliers, five service providers (including specialists in textile testing, textile technology and dyeing and finishing) five branded fashion companies and five retail chains (see appendix 1 for further details). All are UK-based and some also have overseas divisions. Findings were validated at four subsequent expert round-table discussion groups, comprised an extended group of participants, including additional industry and academic experts (Fereday and Muir-Cochrane, 2006).

Semi-structured interviews with industry professionals are appropriate for considering management issues in a real world context (Eisenhardt, 1989; Kim, 2013). Interviewing was selected as a process for collecting meaningful data by asking probing questions that encouraged participants to reflect upon their own experiences and the semi-structured interview format enabled exploration of themes that had emerged from earlier research. The interviews and expert panels were with key informants (Kumar et al., 1993; Restuccia et al., 2016) chosen, either individually or in complementary roles, according to their technical and strategic knowledge.

The purposive sampling strategy was driven by theory rather than representativeness of the population (Öberseder et al., 2013) and participants were chosen to provide a diversity of

¹ The findings in this paper are drawn from the exploratory, early research phase of a multi-method action research project which consisted of initial qualitative research, followed by expert panel discussions and four in depth pilot actions with businesses. The project was funded by Defra (Defra EV0553) to explore current industry processes and behaviours in relation to NPD and the supply chain, in the context of design for clothing longevity.

views, ensure that the research questions could be addressed (Creswell, 2007), and that a degree of saturation could be reached (Boddy, 2016). The participants were drawn from businesses known to the research team through professional networks, specific targeted companies representing leading mass-market retailers and brands with high market share, or their suppliers, and a list of contacts provided by a national industry association. As is the norm for mass-market clothing retailers such as those in our study, the fashion design function is usually located in the suppliers, although some of the retailers had in-house design teams, mainly to develop trend directions to brief suppliers.

The interview schedule was developed by a team of experienced researchers, based on previous research and informed by the literature review and a range of technical reports. Specific sections were aimed at senior managers, technical specialists and design/ sales/ buying representatives. Interviews were undertaken between July 2014 and July 2015. Most lasted from 60-90 minutes, sufficient to gather in-depth insights, and took place at the company premises or by telephone, after informed consent for the interviews was secured in writing. Some also included a tour of production facilities to provide a visual record of the processes followed. Interviews were recorded and transcribed, with summary notes prepared by the interviewers for accuracy. Key themes covered during the interviews included: business context; strategic and practical approaches to sustainability generally, longevity and durability specifically and challenges to achieving these; product testing; design for longevity/durability; the case for durability; clothing care; skills and knowledge and the supply chain.

The interviews were initially analysed and coded according to themes or open codes originally identified from the literature review (Fereday and Muir-Cochrane, 2006), and phenomena drawn from the data itself. The issues of agency and governance were surprising findings that emerged from the research following discussion with participants and dialogue between the researchers to test the coding reliability (Kumar and Noble, 2016) and identify the central theme of product development for longevity. The abductive process enabled these new insights to be explored through comparing to like-minded and dissimilar literature and undertaking subsequent research (Charmaz, 2011; Eisenhardt, 1989) until saturation was reached (Marcos and Prior, 2017). Axial coding subsequently brought

together the initial codes around the central phenomenon to enable the findings to be analysed thematically (Creswell, 2012; Öberseder et al., 2013), using a framework adapted from the Curwen et al. (2012) key principles of sustainable design. The key principles were linked broadly to the original interview themes. 'Company mandate' encompassed data relating to business context, commercial perspectives and strategic approaches to sustainability, longevity and durability. 'Core values match' related to design for and practical approaches to sustainability, longevity and durability, including testing services. 'Gathering and diffusing information' related to codes for knowledge sharing, gain and loss. 'Cross-functional organisation' reflected data on perspectives from different roles, such as product testing and materials sourcing, as well as challenges to achieving sustainability capabilities, such as lack of trust and division; while 'significance of the supply chain' had its own set of codes encompassing critical path management, communication and relationships upstream.

As a test of adequacy (Fereday and Muir-Cochrane, 2006), results were discussed with expert practitioners in the field during follow-up round tables, which picked up on various emergent themes (Öberseder et al., 2013). Construct validity was provided by the multi-disciplinary team, and the project management process secured replicability (Kumar and Noble, 2016). The cycles of interview, analysis and discussion with expert panel members, together with the diversity of participants' roles and expertise provided both reliability and internal validity, enabling the researchers to make appropriate assumptions (Stuart et al., 2002; Fereday and Muir-Cochrane, 2006), and observe and understand patterns of behaviour.

6 Findings

Analysing the findings according to the key themes adapted from Curwen et al. (2012) enabled the research team to apply a framework for designing for sustainable fashion to the more specific design and commercial challenge of clothing longevity. This enabled the framework to be tested in the UK fashion supply chain context to see whether it could be

applied to a mainstream fashion context, rather than a specific project in one branded company.

Retailers address raw material impacts, energy efficiency and ethical compliance, imposing improvements and regulations throughout the supply chain from their position of power and dominance within buyer-supplier relationships. The research confirmed that sustainability is important to them, but suggested that, when asked about their company mandate for clothing longevity, the adoption of new design approaches is rarely prioritised, since extending the longevity of garments challenges other commercial objectives. This is exemplified by comments relating to price, quality, volume and future sales, and relating - not just to the design of clothing - but also to services to the industry, specifically testing. Although one high quality fabric supplier (Supplier E) took the view that “longevity loses sales”, two niche brands identified longevity as core to their brand integrity and Supplier F recognised the commercial benefits of making products that last, suggesting that: “The problem [returns to manufacturer] always comes back to the factory, so needs to be avoided.” Frustrated by the need to compromise on quality and durability, Service provider B, had diversified into an industrial market (supplying upholstery fabric for the auto industry) so that their knowledge, skills and technologies could be put to more effective use.

Many fashion businesses appear to have developed similar working practices, reinforcing the relative hierarchy of actors and ways of working within the NPD process and fortifying accepted ‘norms’ of team structure and individual responsibilities. The research identified few signs of supply chain or multi-functional team re-organisation, and it was generally accepted that retailers hold the balance of power, with evidence that they set standards, maintain control over suppliers, and communicate specifications and expectations. Retailer B, a specialist clothing chain, explained that “ethical values are shared with suppliers through our supplier conferences and supplier manual” but further investigation suggested that the conference was last held three years previously. Meanwhile, Retailer A suggested that more control was needed: “Clearer specification of upstream parts are needed to avoid problems downstream.” However globalisation, fast style turnover, product proliferation and the overriding cost imperative mean that, within these isomorphic ‘norms’, supply chains have become more complex and longer and designers often lack control of upstream processes, such as material choices and manufacturing methods. This type of re-

organisation appears to work against introducing clothing longevity, and there is considerable concern that some technical skills have been lost, under-used or become hard to find. Fabric supplier E claimed that in the UK “years of textile knowledge are being lost to the clothing industry through globalisation.” Some of this knowledge relates specifically to clothing longevity, such as knowledge of wearer trials, fabric finishes and analysis of garment failure, but in other contexts contributes to clothing longevity by ensuring that product retailers, designers and producers can access the skills needed to build in durability and quality.

In contrast, respondents from supplier firms consistently referred to their significant skills and accumulated knowledge, which could positively affect design decisions, but which they felt was under-utilised. When exploring knowledge sharing, it was perceived that there is a knowledge shortfall and reluctance to share knowledge in own-label retail buying teams, who generally drive the new product development process. However, distrust and lack of transparency between large retailers and their suppliers meant that the latter perceived their knowledge to be under-valued, reflecting the finding of Sharma et al. (2010) that cross-disciplinary collaboration in NPD could be improved. Supplier E commented that: “We give designers information about yarn care, but it is not always followed.” Indeed, several of the retailers and brands referred to their lack of trust in testing reports and anticipation that their standards were not adhered to, suggesting that: “Basic tests are box-ticking exercises”. Likewise, there was also a lack of confidence in the consumer, and retailers and brands demonstrated their confusion between providing limited benefits to the consumer, such as ease of clothing care, while also avoiding the finishes and processes that could help to guarantee longevity for aesthetic reasons. Furthermore, some retailers and brands maintained that consumers undermine clothing longevity through inadequate clothing care.

The lack of consideration for their knowledge and skills reported by suppliers is not addressed within stage-gate models of NPD, that present NPD as a straightforward, sequential process (Cooper and Edgett, 2008; Trott, 2017), and this is not reflective of the nuances and iterative nature of scoping and business analysis experienced by our participants. In spite of the lack of trust, there were signs within the supply chain, that suppliers to some retailers were increasingly expected to take on more responsibility for

testing, communicating their own standards and making decisions about fabric/yarn selection and care instructions, within the limited scope of the design pack with which they are provided by the retailer. There was a sense that this added risk is reflected not just in managing the product integrity, but also in taking responsibility for other key supply chain imperatives, such as the critical path schedule, cost implications and balancing the sometimes conflicting demands of different customer departments (such as design and production management). Having relinquished some responsibility, three of the five retailers interviewed admitted that they failed to enforce their own standards for commercial reasons, estimating that, for some brands, up to 10% of all products on sale could have been rejected on technical grounds. Retailer A reflected comments made by others, saying that: “Additional tests and treatments add cost. Rejecting everything that failed visual tests would eliminate 10% of our bulk orders.”

Some respondents acknowledge that durability enhances brand value, regardless of its contribution to sustainability; one suggested that “longevity is integral to upmarket products.” Meanwhile, some small brands had begun to offer more service-oriented solutions, such as repair and alterations, while others were designing modular or more adaptable clothing. These activities can both extend the life of clothing and provide alternative (or additional) revenue streams. Such solutions to enhancing durability need to be ‘designed-in’, requiring a strategic steer, multi-disciplinary approach (Trott, 2017) that spans functional boundaries, and the freedom to apply technological know-how. The findings in this section are summarised in Table 1, which illustrates how the respondents’ experiences related to the key principles within the framework, and goes on to illustrate how these factors can potentially support, as well as inhibit, design for clothing longevity.

Insert Table 1 Pro-longevity factors and longevity inhibitors in the clothing sector

With regard to implementing changes that could support sustainability through clothing longevity, respondents’ recommendations and observations are summarised in Table 2. One of the most consistent themes included knowledge and skills. Supplier B suggested that: “Most retail technologists are naive... if they had a better understanding of manufacturing

they would know if and how garments could be improved to last longer.” This theme pervades throughout each level of the supply chain, mainly related to technical processes. Two of the retailers acknowledged that consumers need better knowledge to support more sustainable purchasing and better clothing care. Suppliers and fabric producers declared a need for better investment in skills and training downstream in the supply chain to improve fabric qualities and processes, while making informed materials choices to support longevity. Meanwhile, two service providers admitted that newer, more robust, testing services need to be developed, while Supplier B suggested that retailers needed educating to understand the consequences on cashflow and investment created by their 120 days payment terms, described as “unethical”.

Table 2: Implementing changes to support longevity

The importance of marketing was proposed by Retailer D: “Marketing should engage the consumer in making changes to the way they purchase” while Brand C and Supplier E emphasised the need for consumers to become emotionally attached to their purchases, consistent with recommendations by Cramer (2011). Brand A suggested that building longevity should be a selling point, while an emphatic statement was made by Service provider E, who claimed that: “The sustainable consumer has to go mainstream. This is a very individual choice at the moment... [change in buyer behaviour] has to go beyond the early adopters.”

A need to redress the balance between costs, revenue and profit margins was identified by both retailers and suppliers. Brand B explained: “We’ve really had to work hard on that [supplier] mentality. We had to ... say ‘this is far better, making less garments but making much more money’.” Meanwhile, Supplier E called for a change in focus away from pure profit, complaining that “reduced price points ... make manufacturers ruthless, lead to lousy products and build pressure on them”, in concurrence with Hoejmose et al.’s (2012) observation that the prevailing commercial drive is to save costs. Several respondents called for greater priority and resources for sustainability improvements through investment in technology, time and training, in line with the aims of the SSCM (Carter and Rogers, 2008). However, supplier E acknowledged the challenges of addressing such issues in a global

supply chain, while supplier A admitted that its main customer's drive to source more directly from the supplier's overseas facilities would remain their priority.

For smaller, innovative retailers and brands, a lack of sufficient power and influence has a lasting impact on the practices of their suppliers. This means that durability standards are often disregarded or of limited, short-term benefit. A key to change is recognised to be greater collaboration (Choi and Hwang, 2015), but there is little evidence of this being implemented across the clothing supply chain, perhaps because of the contrasting, rather than shared, values for clothing longevity.

7 Discussion

Among the major issues in sustainable clothing management is the challenge of managing sustainability without commercial compromise, reinforced by inherent strategic values that favour short-term profit and the prevailing commercial drive to prioritise cost-savings (Hoejmose et al., 2012). The consequences are felt in a number of ways, although these are even more pressing in examining the challenges to product development that prolongs clothing lifetimes.

Our findings confirm that design for clothing longevity is constrained by traditional structures which limit the agency of some actors, particularly suppliers, to fully utilise their skills and knowledge within effective multi-disciplinary teams (Palomo-Lovinski and Hahn, 2014). The lack of agency is associated with a high level mandate to support sustainability, as advocated by Curwen et al. (2012), that is not translated at commercial or operational level into clothing longevity as advocated by policy (Defra, 2011). Furthermore, there is a perceived lack of respect for the knowledge and skills found within the supply chain that constrains the drive for design teams to acquire technical knowledge and to share awareness of sustainability issues amongst NPD colleagues, as advocated by Thabrew et al. (2009). The constraint in gathering and diffusing information not only applies to the sharing of knowledge upstream in the supply chain as observed by Curwen et al. (2012). Our research identifies greater potential for mutual knowledge exchange up and downstream which is constrained by lack of trust and agency, and made more complex by the

globalisation of supply, consistent with Barker's findings (2005). In terms of cross-functional organisation, there is evidence of investment in technical facilities and delegation of technical tasks upstream, but without the personal exchange aspects of teamworking (Curwen et al., 2012) which themselves require time (Luchs et al., 2012) and buy-in of senior managers to support this.

Where design for durability is adopted, this generally supports brand values such as quality (Brun and Castelli, 2008), rather than sustainability *per se* and signs of a commercial case for clothing longevity are not driving change on any scale. There is a lack of enquiry in this field, whether in the agency of design (Farrer, 2010), understanding of use (Taylor, 2013), or generation of new business models. Furthermore, the research exposes a trade-off, or core value mismatch, between durability or quality, represented by clothing longevity, other aspects of sustainability, and commercial gains, mainly represented by cost cutting. With these factors taken into account, the framework illustrated in Table 1 identifies actions that could be termed pro-longevity in clothing, and those that potentially act against it.

The research asked what can be done to address these challenges to achieve sustainable fashion through product longevity. Because the accumulation and flow of capital has changed from district or national to global (Spicer, 2006), and governance structures remain rooted in the West, any solution needs to be global in nature and span organisational boundaries – making the significance of the supply chain (Curwen et al., 2012) a priority. Any solution should encompass greater freedom or agency (Farrer, 2010; Palomo-Lovinski and Hahn, 2014) to express skills and knowledge, both upstream and downstream, in the supply chain. This is necessary to address the current fragmentation of the inter-organisational and multi-disciplinary discourse in order to enable enduring sustainability improvements at an inter-firm and intra-firm level.

Such divergence, or hybrid organisational logic (Spicer, 2006), inhibits the discourse that could commercialise design for clothing longevity, limiting its scale to relatively small organisations and niche markets. Another emphasis, therefore, is the need for an ambitious marketing and communication effort to convince consumers to change and provide them with the wherewithal to do so, and on a wider scale, and recognition that the skills and

synergies required for sustainable supply chain management can lead to wider improvements (Choi and Hwang, 2015; Thabrew et al., 2009).

Underpinning all, is the need for a seed-change in commercial differentiation from cost to quality and durability (Cooper, 2012) with the commercial advantage invested in brand values, consistent with Brun and Castelli (2008). It is important for NPD to be compatible with a company's overall strategy to become a commercial success and consequently it is advisable that sustainability is a core component of a firm's strategy to enable a clothing longevity project to be viable, otherwise its incompatibility with organisational goals could hinder its success.

8 Conclusion

At both a strategic and operational level a lack of governance and agency inhibits technical capability to enhance clothing longevity and restricts infrastructure and processes. This in turn becomes manifest in a loss of skills and lack of willingness to share valuable knowledge for fear of compromising the precarious balance between commercial and sustainability drivers. We found that some businesses were willing to make garments that last longer but that barriers existed that inhibited them from doing so. NPD specialists, including fashion designers and technologists, could be agents of change if provided with the governance, remit and wherewithal to do so. The research adds empirical, commercial data to theoretical work, drawing on diverse schools of thought.

The findings were analysed within a framework devised from the key principles for sustainable design, proposed by Curwen et al. (2012) and we found this to be effective in its application to multiple organisations in the UK. In general, our study aligned with this framework and the other NPD theories that we reviewed, enabling us to offer a higher level of granular detail using empirical data and initiate a discourse on supply chain implications for clothing longevity.

The findings highlight the conflict between commercial drivers and sustainability imperatives, product longevity and other approaches to sustainability, and the challenges implied by hybrid approaches to scale, in a global supply chain context. A key managerial implication is that the company mandate needs to address both commercial and sustainability drivers, reinforced with design and technical innovation, where a fundamental shift is required to give multi-functional design teams the capacity to utilize and share their skills and knowledge within a supportive, but global, business structure. We recommend that clothing companies utilise the insights revealed through this project (Cooper et al., in press) and utilise knowledge such as that in the Clothing Durability Dozen toolkit.

The challenges raised all have strategic implications. Tools to enhance knowledge have been developed for practitioners to implement clothing longevity practices, but the strategic level within businesses is potentially even more important, since practical operations and processes will be implemented based upon the strategies devised by senior management. We propose a move towards more sustainable 'slower' fashion in the clothing sector, of which longer lasting clothing is an option, away from the prevailing, unsustainable fast fashion paradigm, underpinned by the support of industry bodies, consumer demand and government policy. The idea of providing longer lasting clothing should be presented positively as future-orientated, in that it seeks to preserve the environment for the future, to supersede its former image as outdated and rooted in the past.

This study found that challenges to enhancing clothing longevity could be addressed (via knowledge, skills, cross-functional organisation, and leveraging the supply chain) if managerial decisions were taken to dismantle inhibitors to longevity where possible and to enhance the agency of NPD team members, especially those in suppliers, within the limits of financial sustainability.

Strong relational bonds between companies and their suppliers can assist in driving innovative solutions (Jean et al., 2017) and therefore building links between actors in fashion companies and their suppliers has the potential to facilitate innovative and sustainable product development. Consequently, fostering an environment where NPD teams can work closely and openly with suppliers at the design and prototyping stages, to

align core values and share knowledge, could be mutually beneficial and facilitate product longevity. Although such an environment could be instigated by individual organisations, the support of industry bodies or government policy could improve this situation.

Since studies on supply chain implications for clothing longevity, are rare, further research into this field would benefit from the development of a theoretical model, which could be based on a grounded approach, aimed at both academics and NPD practitioners. There is an opportunity to explore in more detail the challenges faced which, operationally, include limited knowledge-sharing up and down the supply chain and barriers to cross-functional collaboration. However, there is also a need to understand the strategic challenges if longer-lasting clothing is to be adopted and these include defining a company mandate that helps to align core values and which respects the contribution of the supply chain to meet its goals. Furthermore, the temporal limitations of this study could be addressed by conducting longitudinal research to assess progress with sustainable clothing practice and how this is represented in literature. In addition, NPD models could be modified to take into account issues of environmental sustainability and longevity in clothing and other product sectors, to encourage the wider adoption of such practices, to support both the environment and society. Further research should also enhance understanding of the commercial cost-benefit equation and evaluate alternative business models. Finally, since a limitation of the research is its focus on the UK fashion business, there is an opportunity to further explore these issues in other product sectors and market levels and beyond the national scale. The approach adopted in this study could also be applied to research into sustainability strategies in NPD more generally, leading to the development and sharing of knowledge that could enable more widespread positive change towards environmental sustainability.

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Table 1 Pro-longevity factors and longevity inhibitors in the clothing sector

Open Code +	Pro-longevity	Longevity inhibitors	Open code -
Positive factors	Company mandate		Negative factors
Commercial	Longevity is integral to upmarket products. Supplier F	The business case is only concerned with volume: "Longevity loses sales". Supplier E	Commercial
Governance	Sustainability and longevity is integral to brand strategy for this brand. Brand D	"Price/profit motive makes manufacturers ruthless and leads to lousy products" Supplier E	Commercial
Change	Standards have been increased to meet export requirements to China. Brand A L/D	Lack of commercial drivers to develop tests for durability. Round Table	Commercial
Governance	Unless there is company buy-in, designers may have the knowledge but not the capacity to make change. Round table	Quality, not durability, is a key attribute of our product. Brand C	Commercial
Agency	Poor durability leads to returns to manufacturer: "The problem always comes back to the factory, so needs to be avoided." Supplier F	The metabolism of consumption is fast. The speed of change is slow – the case for the future needs plans for culture, concerns, faster market change. Round table	Governance
Commercial	"Made in the UK makes the sale!" Brand B	Designers lack capacity to influence change in large companies and lack the time to do so in small firms. Round table	Agency
	Core values match: aesthetic, sustainability, commercial		
Commercial	We have to balance the power of newness [to consumer] against the pain & cost of replacement. Round table	"We say it is 24-hour clothing" to be worn more, rather than for longer. Retailer B	Design for Longevity & Durability
Design for L/D	Re: finishes for textiles and yarn that enhance longevity. "The secret of development is in new, high tech fibres". Brand B	Quality tends to be reduced to meet price points. Supplier E	Design for Longevity & Durability
Design for L/D	"We do the heavy lifting design to make things last a little longer without the consumer changing their behaviour". Retailer A	Basic tests are "box-ticking exercises." Additional tests and treatments add cost. Rejecting everything that failed visual tests would eliminate 10% of our bulk orders. "Commercial means not always meeting the standards." Supplier B	Commercial/testing
Design for L/D	"It's better to produce non-pill garments than it is to instruct the consumer to manage pills". Brand E	Customers give mixed messages because design and technical departments disagree about aesthetics and suitability of fabrics for their designs. Supplier D	Design for Longevity & Durability

Trust	Samples are risk assessed by suppliers/ brands. New ones, or high risk, are subject to extended tests. "We can re-engineer the product – given time." Retailer C/ Supplier C	Durable fabrics or those with treatments lose their aesthetics and feel. Treatments and finishes are only applied if requested by the customer because of extra cost (between a few pence to \$1 per unit) and time. Supplier F	Commercial/ design
Gathering and diffusing information			
Gain knowledge	The use phase of clothing is not well-understood by brands – youth are demonised for wanting fast fashion, but there is potential to offer alternatives. Round table	Tacit knowledge of failure and returns is not recorded and could be used to analyse longevity potential. Round table	Lost knowledge
Knowledge sharing	"Ethical values are shared with suppliers through our supplier conferences and supplier manual." Retailer B	Technical knowledge is being lost/ inadequate/ needs to be passed on throughout the supply chain. Some skills/ knowledge that would support longevity are hard to find, such as 'linking' in knit manufacture, and knowledge to conduct wearer trials. Exacerbated by globalisation. Suppliers E & F	Lost knowledge
Knowledge sharing	Technical knowledge needs to be passed on, so that knowledge in practice can be developed. We need to be able to understand and influence the consumer. Round table	There is a good basic understanding of fabric performance in production companies. Failures are notified, but are not always stopped. "We give designers information about yarn care, but it is not always followed." Suppliers D/ F	Knowledge sharing/ agency
Change	More knowledge would help to segment products and design for slow and fast fashion Retailer A	"Try telling [top designer brand X] not to use a fabric for a certain thing, it's impossible!" Supplier D	Lack of trust/ agency
Cross functional organisation			
Trust	Suppliers are increasingly trusted to manage upstream risk – carry out tests, determine which wash standards to apply from guidelines provided. Retailer C	Change needs the buy-in of all departments, marketing and new designers.... Staff churn reduces problem-solving capacity. Round Table	Capability
Change	We can finish fabrics to enhance durability, but have moved towards technical textiles because our customers have moved to China. Techtext markets value longevity. Service A	There is a lack of trust and confidence in process improvements carried out at the production stage – such as better fibre/ yarn treatments; the tests behind reports, etc. Round table	Division
Capability	"We are developing in-house testing facilities in all our factories" Supplier A	"Design 'want' and production 'rejects' – there is inconsistency within retail/ brands." Supplier C	Division
Supply Chain Significance			

Communication	Customers provide a design pack/ full specification for all products. For one brand queries from the global sourcing offices are addressed back to UK as an additional technical check. Retailer C/ Supplier F	"We lack power over our suppliers. We are a small, relatively new team with up to 10% failure rate." Retailer A	Lack of agency
Communication	Product specifications need more specific detail in order to support durability. "Clearer specification of upstream parts are needed to avoid problems downstream." Round table	"We distrust suppliers' test reports – so we test everything again... yarn suppliers don't always follow specifications and we lack the power to impose this." Supplier F	Lack of trust/ relationships
Critical path	Our buying calendar is twelve months. "We have the luxury [time] of being able to change and develop new products." Brand E	Decisions made in-house predate the test agreement, putting pressure on the manufacturer to avoid lateness. Round Table	Critical path
Agency	Design vs designer- needs to include commercial, technical & supply chain. Round table	"Many textile finishes are at the end of the textile supply chain – so puts pressure on speed." Service A	Critical Path
Agency/ Change	Core product development rests with our regular suppliers. Newness comes from less proven ones. Could designers be the agents of change? Round table	"There is a lack of traceability". Greater transparency is needed throughout the supply chain. There is a lack of collaboration between fabric and laundry testing.	Lack Communication/ collaboration
Change	Repositioning after sales services (repair etc.) as luxury items would change behaviour. Round table	Product development, yarn sourcing, testing have moved to China. "The UK has closed down" except for high value niches. Supplier A	Lost capability

Table 2: Implementing changes to support longevity

	Technical (skills, knowledge, processes)	Strategic/ managerial (processes, infrastructure, resources)
Retailers	<p>Make longer lasting garments commercially ... it should be a win-win. Retailer D</p> <p>Develop knowledge/ skills to improve durable fabric aesthetics and choose appropriate materials. Retailers B/D</p>	<p>Marketing should work towards influencing consumers in their sustainable purchasing decisions. Retail D</p> <p>Address the cost/margin priority that buying teams are working towards. Prioritise resources that could make changes. Retail A</p>
Brands	<p>Help stakeholders to recognise that making good quality products ultimately avoids costly problems for the designers / technologists. Brand A</p> <p>Help to inform the choice between sustainable or durable fabrics, or improve the qualities of both. Brand D</p> <p>Invest in training and product development for designers/ technologists to enhance acquisition of knowledge/ experience. Brand A</p> <p>Provide more help and advice to empower customers to care for clothing more sustainably. Brand D</p>	<p>Make more effort to promote the advantages of selling good quality products that will last a long time – this could be a selling point. Brand A</p> <p>Understand how improving quality and durability brings higher margins for lower volumes, and how to exploit the commercial benefits. Brand B</p> <p>For brands, leverage the emotional connection between the customer and the product, as this supports longevity. Brand C/ Supplier E</p>
Suppliers	<p>Ensure that retail technologists understand manufacturing and how garments could be improved to last longer. Supplier B</p> <p>Add at least 1 aspect of sustainability to all products. Buyers can be incentivised to achieve this. Longevity is currently not one of these aspects. Supplier A</p> <p>Avoid cutting corners to reduce costs by using less yarn ... this is a waste of good yarn for inappropriate uses. Supplier E</p> <p>Segment fast from slow fashion products and develop protocols to reduce the negative impact of each.</p>	<p>Retailers need to understand what constitutes an ethical and unethical price, and improve their pricing policies to ensure that suppliers are able to invest in change. Supplier B</p> <p>Our priorities lie elsewhere because our customer is restructuring. Providing greater certainty in the supply chain would enable suppliers to focus on making positive changes. Supplier A</p> <p>Quality and skills have been lost – action is needed to retain and rebuild knowledge in the global supply chain. Supplier E</p> <p>Change the focus from profit and price points, which undermines product quality and commercial relations in favour of cost cutting. Supplier E</p> <p>Provide incentives to invest in technology that helps improve fabric quality and durability; and to address the focus on profit and price points, which undermine product quality and commercial relations. Supplier E</p>
Services	<p>Holistic, robust and reproducible testing for longevity should be developed and adopted. Service C/ D</p>	<p>Enable the sustainable consumer to go mainstream, beyond the early adopters. Service E.</p> <p><i>Make longevity cool.</i> Panel expert</p>

Appendix 1: Research participants

Ref Code	Role of participant	Global Influence	Nature of business
Supplier A Dir	MD	Ownership Far East; Global Facilities including UK	Supplier of womens and mens outerwear and underwear
Supplier A Tech	Technical Executive		
Supplier A Des	Senior Designer		
Supplier B Dir	General Manager/ Commercial Director	UK based	Knitwear manufacture
Supplier B Tech	Garment/ Fabric Technologist		
Supplier C Dir	Owner	UK based	Knitwear manufacture
Supplier D	Design/Sales Director	UK based	Fabric manufacturer
Supplier E Dir	Owner	UK based	Yarn spinners
Supplier E Dir	Director		
Supplier F Dir	MD	Overseas owned; UK based	Upmarket Knitwear manufacture
Brand A Prod	Knitwear Product Manager	UK owned; global distribution	Upmarket menswear retail and wholesale
Brand B Des	Design Director/co-owner	UK owned and distribution	Independent womenswear retailer and wholesaler
Brand C CSR	Sustainability Manager	UK owned; Global sales	Upmarket womens and menswear retailer and wholesaler
Brand D Tech1	Head of Technical	UK owned; Global sales	Upmarket womenswear retailer and wholesaler
Brand D Tech2	Garment Technician		
Brand E	Technical Manager	UK based; global distribution	Upmarket mens and womens knitwear brand
Retail A Source	Technical and Sourcing Manager	UK owned and distribution	Supermarket
Retail A Tech	Senior Technologist		
Retail A Merch	Senior Merchandiser		
Retail A Buyer	Assistant Buyer		
Retail B	Senior Buyer	UK owned; Global sales	Midmarket womens fashion retailer and wholesale
Retail C CSR	Sustainability manager	UK based; global distribution	Midmarket clothing retailer and online sales
Retail C CSR	Technical manager		
Brand E Dir	Commercial Director	UK owned; overseas production	Upmarket womens knitwear brand
Retail D Tech	Technical Manager	UK based; global distribution	Midmarket clothing retailer and online sales
Retail D Mbuy	Menswear buyer		
Retail D Wbuy	Womenswear buyer		
Retail E	Commercial director Senior childrenswear buyer	UK based; global distribution	Midmarket online clothing retailer
Service A Tech	MD and Technical	UK based	Dyeing and finishing
Service B Tech	Technical Manager	UK based	Fabric finisher
Service C	Technical Knowledge Manager	UK base of global corporation	Specialist testing services provider
Service D	UK Softlines Manager	UK base; global service provision	Specialist testing services provider
Service E	Technical consultant	Freelance	Fabric technician