



Developing Closed Loop Supply Chains for Environmental Sustainability: Insights from a UK clothing case study

Journal:	<i>Journal of Manufacturing Technology Management</i>
Manuscript ID	JMTM-12-2016-0175.R3
Manuscript Type:	Article
Keywords:	Buyer-supplier relationships, Green operations, Environment, Sustainable production

SCHOLARONE™
Manuscripts

Abstract

Purpose - forward and reverse supply chains form a 'closed loop' when managed in a coordinated way and this 'cradle to cradle' responsibility has strong relevance to addressing environmental sustainability in global supply chains. The extensive outsourcing of manufacturing has created highly fragmented supply chains, which is strongly evidenced within the UK clothing industry, and it presents major environmental challenges, particularly around waste and resource use. The paper investigates how a Closed Loop Supply Chain (CLSC) can be successfully developed to address environmental sustainability.

Design/methodology/approach - the Natural Resource Based View (NRBV) acknowledges the importance of a firm's tangible and intangible resources, as well as socially complex relationships, and provides 3 path dependent strategies for achieving environmentally-based competitive advantage. Via an in-depth case study of a UK-based clothing firm the NRBV is employed as a framework for understanding the processes that a focal firm needs to engage in to develop a CLSC, and the contribution that is made by its resources and supplier relationships.

Findings - the findings illustrate the key importance of strategic resources and shared vision and principles between the focal firm and its suppliers, in order to progress from a more reactive pollution prevention strategy to a fully embedded CLSC response to environmental sustainability. The case study highlights the need to extend the current CLSC model to integrate the design function and end customer; the design function ensures that appropriate environmental practices can be implemented, and customers represent a key stakeholder as they enable the reverse flows required to maximise value and minimise waste.

Originality/value - the NRBV and its 3 path-dependent strategies is an established framework for understanding environmentally-based competitive advantage, but has not previously been explicitly employed to investigate CLSCs. This research therefore provides valuable insight into the applicability of this model in the supply chain field, and the key role of tangible and intangible resources and socially complex supplier relationships in developing and achieving a CLSC.

Keywords: Closed Loop Supply Chains, Environmental Sustainability, Natural Resource Based View of the Firm (NRBV), supplier relationships

Introduction

Globalisation and economic trends have created highly complex supply chains (Varma et al., 2006), and there has been a significant shift to firms outsourcing non-core activities to overseas suppliers (Darnall et al., 2008). This has been especially evident in the UK clothing industry, where cost pressures, competition and quota removal have forced firms to outsource the manufacturing function, and focus on customer-facing and design activities (Allwood et al., 2006). It is also an industry that has received significant negative press regarding its environmental impacts, particularly in relation to the responsible use of natural resources and chemicals, and the waste and pollution it generates (Fletcher & Grose, 2012). It therefore represents a highly appropriate focus for this paper, as successfully addressing such major environmental issues in this complex industry has implications for global supply chain practice.

Waste and emissions caused by production processes throughout the global supply chain are major sources of environmental problems, and a focus on pollution prevention is seen as one of the most immediate ways to tackle these issues (Min & Galle, 1997). Resource reduction through recycling, re-use and waste elimination extends this responsibility further (Carter & Ellram, 1998), and can lead to cost savings and enhanced competitiveness (Rao & Holt, 2005). Developing the right kind of supply chain can be key to addressing environmental sustainability, with firms recognising the systemic and strategic implications of managing the numerous flows in the supply chain (Defee et al., 2009). Firms which apply a systems approach can facilitate the adoption and diffusion of environmentally-focused practices (Florida, 1996), and move towards a Closed Loop Supply Chain (CLSC). Forward and reverse supply chains form a 'closed loop' when managed in a coordinated way (Kleindorfer et al., 2005), and a 'cradle to cradle' responsibility, which acknowledges all stages in a product's lifecycle, is increasingly considered a competitive necessity (Das & Posinasetti, 2015; Elia & Gnani, 2015).

CLSC research has evolved from a focus on remanufacturing in the 1990s; remanufacturing is a key closed loop practice as it replaces worn, broken or obsolete parts from a product (Pun, 2006), and contributes to reducing a company's environmental burden (Jena & Sarmah, 2014). As a result of diminishing life cycles, the commoditisation of products, and decreasing profit margins closed loops have become increasingly important in industrial practice for the systematic management of resources and waste. It represents a rich and significant area for research development, with integrative methodological approaches required to provide practical insights and solutions to the design, control, and operation of CLSCs (Guide & Van Wassenhove, 2009). There is an acknowledged need to move to more practical and values-based views of CLSCs, with academics becoming familiar with industry practice and the challenges it creates (Guide & Van Wassenhove, 2009). Through an in-depth case study of a focal firm the goal of this paper is to apply a theoretical lens that enables a rich, multi-faceted analysis of environmental practices and challenges in a specific industry, and to understand the role that suppliers have in the successful implementation and coordination of a CLSC.

The theoretical framework of the Natural Resource Based View of the firm (NRBV), which evolved from the RBV in response to environmental sustainability is employed. It recognises the importance of tangible and intangible resources at the firm and supply chain levels, and presents 3 path-dependent strategies that progress from pollution prevention to sustainability. It offers significant potential to understand the development of CLSCs, and how supplier relationships and the resources they generate contribute to a value and *values*-driven supply chain. The paper reviews relevant environmental sustainability and CLSC literature in relation to the NRBV, and then presents a case study of a UK clothing SME which has strong environmental principles and a CLSC ethos. The findings are discussed and provide valuable insight into the development of a CLSC against the NRBV framework, and the role

1
2
3 that strategic resources and supplier relationships play in its achievement. The paper therefore contributes
4 to both CLSC research and practice; its use of the NRBV allows a more holistic understanding of how
5 environmental sustainability integrates with intangible, embedded social components such as trust and
6 principles, and provides practitioners an appropriate structure for decision-making on the design,
7 implementation and management of a CLSC. Suggestions for future research directions are also made.
8
9

10 **Literature Review**

11 A set of search criteria related to environmental sustainability and closed loop supply chains was applied
12 to identify the most relevant papers for review; as well as using these specific search terms the
13 keywords/phrases of green supply chains, environmental supply chains, environmental responsibility and
14 sustainable/responsible supply chains were employed. The search was limited to journals produced in
15 English; for quality purposes searches were limited to journals rated from 2 – 4* in the ABS journal
16 rankings (2016). The search databases used were Science Direct, EBSCO and Emerald Fulltext, and as
17 each search was completed the abstracts were reviewed to ensure the relevance of the results. Recognising
18 the interdisciplinary nature of the subject areas, and the fact that environmental sustainability and CLSCs
19 are still evolving concepts, it was subsequently deemed important to include certain journals that fell
20 outside this scope, to ensure that the most current and relevant research in the field was included.
21
22
23

24 **Closed Loop Supply Chains**

25 Every product generated, transported, used and discarded within a supply chain has some degree of
26 impact on the environment, and is a function of the material and energy consumed, and wastes released in
27 its lifecycle (Tsoufas & Pappis, 2006). Increasing environmental consciousness across multiple industries
28 together with stricter legislation (Neto et al., 2010) has made product disposal a critical issue for firms
29 (Jena & Sarmah, 2014). Recovery and recycling are practical and value-maximising alternatives to
30 landfill disposal (Guide & Van Wassenhove, 2009), and there is growing recognition that with increased
31 global consumption of goods, the quantity and availability of raw materials will deplete significantly
32 (Kumar & Putnam, 2008), so resources need to be used (and re-used). To manage the environmental
33 performance of a supply chain all stages need to be addressed (Tsoufas & Pappis, 2006), as any activity
34 may have a negative impact. Environmental issues cannot be managed in isolation from other supply
35 chain activities (Vachon & Klassen, 2008), and companies must design, produce, distribute, and dispose
36 of products in a way that minimises the associated environmental impacts (O'Brien, 1999).
37
38
39

40 Closed loops consider all stages of the supply chain, and are defined as the *'design, control, and*
41 *operation of a system to maximise value creation over the entire life cycle of a product with dynamic*
42 *recovery of value from different types and volumes of returns over time'* (Guide & Van Wassenhove,
43 2009, p.10). The CLSC as illustrated in Figure 1 recovers added value by reusing products and/or their
44 components (Guide & Van Wassenhove, 2009). It is characterised by the firm's active involvement in the
45 recovery process in order to extend a product's life or manage final disposal (Klassen and Johnson in
46 New & Westbrook, 2004). The key goal is to keep all materials within the lifecycle and minimise any
47 flow into the external environment (Sarkis, 1995). The CLSC concept is therefore of key importance in
48 addressing the key environmental concerns of waste and hazardous materials through pollution prevention
49 activities, as well as generating economic value through extending product life and enabling the reuse,
50 remanufacturing and recycling of products (Blumberg, 2005).
51
52
53
54
55
56
57
58
59
60

FIGURE 1 HERE

A key way to improve environmental sustainability within the CLSC is to lengthen the life of materials and products, and recycling can generate additional revenue streams while also reducing the level and cost of waste disposal (Sarkis et al., 2010b). By incorporating repair, reuse and remanufacturing as well as recycling the CLSC model reduces waste, and makes efficient and effective use of resources at all stages (Das & Posinasetti, 2015). Closed loops increasingly represent a critical activity for firms, with economic and environmental impacts pushing the need to integrate forward and reverse product flows, rather than just 'greening' individual production processes. (Elia & Gnoni, 2015). The CLSC is becoming a preferred model for more progressive companies due to its potential for value recovery, positive response to environmental sustainability and growing consumer awareness of environmental issues (Das & Posinasetti, 2015). There are specific environmental concepts and practices that form an explicit part of or actively contribute to achieving the CLSC illustrated in Figure 1, and they are evaluated and discussed in the following sections. However, it is recognised that most current environmental activity is in pollution prevention rather than fully coordinated supply chains, and despite its recognised importance in addressing sustainability the CLSC is still far from being an industry norm.

CLSC Environmental Concepts and Practices*Design for the Environment and Design for Remanufacturing*

The design function is key to the CLSC, as it sits at the start of the supply chain and enables specific environmental practices to be implemented and achieved effectively. Design for the Environment (DfE) systematically considers design performance with respect to environmental objectives over the full product and process life cycle (Masclé & Zhao, 2008). It enables firms to address the environment (Preuss, 2005b), and develop recoverable products which are durable, reusable, harmlessly recoverable and environmentally compatible in disposal (Tsoufias & Pappis, 2006). Three key DfE objectives are maximisation of profit over a product's life span, maximisation of the number of parts reused, and minimisation of landfill waste (Masclé & Zhao, 2008). Difficulties associated with DfE are designers' unfamiliarity with the process and lack of integration with other design tools (Albino et al., 2009), which lead to issues in coordinating the process with manufacturing. It is an emerging tool, which requires refinement to be effective and depends on material availability and the technical capability of the supply chain (Preuss, 2005b).

Design for Remanufacturing (DfRem) aims to enhance remanufacturability, and requires the design function to actively consider each remanufacturing step, and how the design of the product will affect them (Hatcher et al, 2011). It can be seen as part of the concurrent engineering process, but research also indicates that DfRem is actually a collection of many tasks or considerations whose prioritisation will differ depending on the processing needs of the product (Sundin, 2005). Specific product properties may have a positive or negative effect upon particular remanufacturing process steps, such as disassembly or cleaning, and improving remanufacturing efficiency through design may make it a more viable and lucrative product end-of-life strategy (Hatcher et al, 2011). Further dimensions of integrating environmental concern in the design stage which contribute to 'closing the loop' include Design for Recycling (DFR) and Design for Disassembly (DFD) (Gupta, 1995). These complementary approaches allow for more efficient and profitable reuse/disposal of product components (Kumar & Putnam, 2008).

Product Stewardship

The concept of product stewardship incorporates these design-related responses to the environment, and explicitly considers the environmental impact of products from the purchase of raw materials to how the

product is disposed at the end-of-life, and aims to reduce the environmental burden of products (Wong et al., 2012). It is representative of a cradle to grave (or cradle) responsibility for the lifecycle of a product (Angell and Klassen, 1999), and is focused on 'product-based green supply' (Seuring, 2008). The goal of product stewardship is to keep all materials within the lifecycle and minimise any flow into the external environment (Sarkis, 1995). It therefore considers the environmental impact in of a product in its design, packaging, and materials used, and promotes the recycling, remanufacturing and reuse of materials/components, and using recyclable parts (Wong et al., 2012).

Product stewardship extends the environmental perspective to the entire value chain to include internal and external stakeholders such as R&D, designers and suppliers, and is therefore crucial to the integration and coordination required in the CLSC. Examples include redesigning products and processes, which further emphasises the key role of the design function, using renewable resources and working with suppliers to prevent pollution (Rusinko, 2007). It represents one of 3 capability-based strategies that form the Natural Resource Based View of the Firm (NRBV), and progresses a firm from reactive pollution prevention activities to a more proactive and integrated response to environmental sustainability.

Reverse Logistics

Traditional logistics manages the supply of goods from the producer to the end consumer (Lippman, 2001), while Reverse Logistics (RL) relates to products returned by the customer to the focal firm. In line with the presented CLSC model it has the purpose of recovering and potentially generating value (Blumberg, 2005) or properly disposing of products (Lippman, 2001), and is a '*process whereby companies can become more environmentally efficient through recycling, reusing and reducing the amount of materials used*' (Carter & Ellram, 1998, p.85). RL provides the maximum utilisation of used products, where every output is returned to natural systems or becomes an input for manufacturing another product (Tsoufas & Pappis, 2006). Products, parts, subassemblies and materials represent growing values and economic opportunities at the end of the supply chain (Blumberg, 2005), and the holistic nature of reverse distribution actively aims to reduce resources in the forward system so that fewer materials flow back, reuse and remanufacturing is possible and recycling facilitated (Carter & Ellram, 1998). RL is therefore the function that allows the supply chain loop to be closed, and enables the implementation of the environment-focused activities of recycling, reuse, remanufacturing and repair.

Recycling, Reuse, Remanufacturing and Repair

Waste products and emissions can be recycled as a raw material for use in the same or different production process; processed to be reused; and used for a different useful application. Reclaimed material can also be sold to another company (Gupta, 1995). Recycling and remanufacturing work in parallel, with the major distinction between material recovery (recycling) and added value recovery (remanufacturing) (Kenne et al., 2012). Recycling requires disassembly of the waste or returned product, separation of parts and material reprocessing, and denotes material recovery without conserving any of the original product's features (Field and Sroufe, 2007). Remanufacturing replaces worn, broken or obsolete parts from a product, with the aim of returning it to new or better than new condition (Pun, 2006). Both approaches can benefit firms economically as costs will be lower than using 'virgin' materials; environmental consequences are generally higher for the initial processing of virgin material, as well as regulations and associated costs (Field & Sroufe, 2007).

Remanufacturing not only helps in reducing a company's environmental burden, but can also reduce production costs (Jena & Sarmah, 2014). It is the process of returning a used product to at least original equipment manufacturer (OEM) original performance, and includes sorting, inspection, disassembly,

cleaning, reprocessing and reassembly, and the replacement of parts which cannot be brought back to original quality (Hatcher et al., 2011). It is an important aspect of CLSCs because it extends products' lives and integrates back into the production chain used components that would otherwise have entered landfill (Sundin et al., 2009, Hatcher et al., 2011). By providing customers with remanufactured products, companies can provide the same level of service using fewer resources, thereby reducing the resource intensity and increase the eco-efficiency of product systems (Kerr et al., 2001).

Reuse represents a form of recycling where the recycled product retains all the properties of the original (Sarkis, 1995), and makes use of good components from retired assemblies, while repair brings damaged components back to a functional condition (Kumar & Putnam, 2008). Repair activities are a growing area, and a repair network can itself be considered as a closed loop with products flowing between the manufacturer and its customers (Kusumastuti et al., 2008). It is less represented in the current CLSC literature, but is a key way to reduce disposal until a product's true end-of-life.

Managing Supplier Relationships in the CLSC

A key challenge in the CLSC *'is not just how to manage irregular reverse flows, but how to obtain them in the first place'* (Seitz & Peattie, 2004). This highlights the importance of RL to closed loops and the practical issues associated with incentivising and enabling products to be returned to source; these issues are exaggerated by the complex and global nature of today's supply chains. It also indicates the importance of managing both supplier and consumer relationships to ensure the CLSC operates effectively. Research to understand global supply chains is progressively moving away from conventional economic, technological and tangible mechanisms towards more relational, inter-organisational approaches (Pilbeam et al. 2012), which focus on the interaction between actors in a supply network and how they cooperate, stimulate and influence each other (van Bommel 2011).

Transactional relationships focus on increasing the number of suppliers or frequently switching suppliers to economise costs, whereas relational approaches focus on the sharing of information (Power 2005; Preuss 2005b). Spekman et al. (1998) consider cooperation as the threshold level of supply chain interaction where firms exchange some essential information and engage some suppliers in long-term relationships, while in coordination workflow and information is exchanged to allow more seamless linkages. Collaboration represents the optimum level and occurs when two or more independent firms work in partnership to plan and execute supply chain operations (Nyaga et al., 2010). Collaborative relationships are characterised by information sharing, a long-term approach and mutual advantage (Preuss, 2005a) with joint efforts creating value that cannot be achieved independently (Nyaga et al., 2010). They require the development of trust and commitment between buyers and suppliers (Attaran & Attaran, 2007), with trust seen as a prerequisite to success (Varma et al., 2006). Individual relationships and close-knit social relations (van Bommel 2011) can nurture trust and informal networks.

Supply chain research and practice tends to focus on tangible processes, and this extends to addressing environmental sustainability (Ashby et al., 2012). There is little in the current literature that explicitly recognises the importance of relationships in developing CLSCs (Jena & Sarmah, 2014), and to address this research gap there is a need to apply theoretical frameworks that can fully address both the tangible and intangible dimensions of CLSCs (Ostlin et al., 2008). This paper therefore employs the Natural Resource Based View (NRBV) as it incorporates different dimensions of environmental responsibility, and recognises the role of tangible and intangible resources in achieving sustainability. There is increasing awareness of the importance of resources which develop from relationships with suppliers and network structures. The relational view of supply chains (van Bommel, 2011) emphasises the benefits of common resources that partners cannot generate independently; relational resources stem from the focal

1
2
3 firm's network ties and their emergence is viewed as a context and path-dependent process. As these
4 resources are difficult to imitate, they can form a significant basis for sustainable competitive advantage,
5 and can generate extensive value for interconnected organisations (Barrutia et al., 2015). Trust is
6 considered a key relational resource and its prominence in current sustainability research stresses its
7 highly beneficial effects in relational contexts (Simpson and Power 2005, Barrutia et al., 2015).

8 9 *The Natural Resource Based View*

10 The RBV suggests that firms are able to create and sustain competitive advantages through the collection
11 and integration of strategic resources that are rare, valuable, inimitable, and non-substitutable (Barney &
12 Hesterley, 2008). It has become important in OM and supply chain research as it can be used to
13 deconstruct the sources of competitive advantage both internally and across cooperative partnerships, and
14 therefore provides a unique means of supply chain analysis. Each supply chain activity requires particular
15 resources and capabilities, but it is important, and more challenging, to integrate the existing capabilities
16 across the supply chain, and leverage them effectively (Hitt et al., 2016). Firms that are able to build their
17 supply chain capabilities can use them to gain competitive advantages (Barney, 2012), and create socially
18 complex resources through on-going interactions with their supplier network.

19 The NRBV (Hart, 1995) is an evolution of the Resource Based View of the firm (RBV), which entails
20 that resources and capabilities that are valuable, rare, and inimitable determine the competitive position of
21 firms with *environmental* considerations (Barney, 1991). A firm can achieve superior performance if it
22 has the capability to exploit as well as preserve natural resources in its operating environment, and firms
23 embracing the product-related environmental practices detailed above and utilising them intensively in
24 their operations and supply chain stand a higher chance for preserving the natural resources in their
25 environment (Wong et al., 2012). The socially complex capability of environmentally-focused firms is
26 developed where partner firms are engaged in coordinated organisational actions; such capability allows
27 firms to access the resources of their suppliers, and the inherent complexity in supplier coordination and
28 collaboration are difficult to imitate (Wong et al., 2012).

29 The NRBV recognises the key role of tacit and socially complex resources as well as cultural
30 embeddedness, shared visions and strong moral leadership in addressing the environment, and building on
31 these principles firms need to develop environmentally sustainable capabilities to remain competitive.
32 Hart (1995) proposes 3 interconnected strategies: pollution prevention, product stewardship and
33 sustainability. The 3 strategies (Table 1) are interconnected through path-dependency and embeddedness,
34 and offer a framework for understanding how to coordinate the different CLSC components documented
35 in the literature. They follow a sequence beginning with pollution prevention through to sustainability,
36 and each strategy builds on the prior capability. The pollution prevention strategy links to the core
37 capability of continuous improvement (CI); most research to date has focused on the application of this
38 strategic capability, and how to prevent pollution in a cost-effective way through the minimization of
39 waste and emissions (Mena et al., 2014). While it is a better response to environmental issues than
40 pollution control, it is still considered reactive in nature (Vachon & Klassen, 2006).

41 42 **TABLE 1 HERE**

43 Following the NRBV framework the focal firm then extends from internal pollution prevention
44 practices towards cooperation with external stakeholders, including suppliers. The core capability of the
45 product stewardship strategy is the integration of stakeholders' environmental interests, and requires
46 information exchange and collaboration on environmental impact reduction (Grekova et al., 2014),
47 emphasizing the need for relational resources (Barrutia et al., 2015), and inter-organisational relationships
48

1
2
3 which generate socially complex resources (Mena et al., 2014). Research is beginning to address the
4 concept of product stewardship, and improved relationships across supply networks can lead to improved
5 and more proactive environmental outcomes. Firms depend on suppliers to provide environmentally
6 friendly materials, and closer relationships can lead to greater supplier involvement in environmental
7 initiatives, such as recycling and reuse (Mena et al., 2014).

8
9 Table 1 indicates the importance of shared vision as a key resource for moving from reactive
10 environmental approaches, illustrated by pollution prevention to the proactive, future-focused and value-
11 seeking responses to sustainability advocated in CLSC research. The NRBV aligns with currently
12 documented responses to environmental responsibility in supply chains, from a short-term, transactional
13 approach where specific processes are simply 'greened' (Ashby et al., 2012), to taking a product lifecycle
14 view, through to a long-term and proactive commitment to minimise the firm's environmental burden as it
15 grows and develops (New & Westbrook, 2004). This final position aligns directly with the CLSC
16 concept, as to succeed it needs to take full account of the environment throughout the firm (Das &
17 Posinasetti, 2015; Elia & Gnoni, 2015), and requires a proactive, networked supply chain, but it is
18 currently under-developed within the field and represents a key research gap.

19
20 The embeddedness of environmental principles in a firm's culture and supply chain can represent an
21 inimitable resource (Barney et al., 2001), and the NRBV's emphasis on shared vision as the key resource
22 for a sustainability strategy offers potential for understanding how supplier relationships contribute to the
23 achievement of a CLSC. Supply chain collaboration can be a source of sustained competitive advantage
24 because it grows historically and involves socially complex interactions (Mena et al., 2014), and the need
25 for a shared vision to achieve sustainability implies the collaborative involvement of suppliers. The
26 research on the NRBV capabilities of product stewardship and sustainability is nascent, and this paper
27 aims to address this key gap through a focus on the role of suppliers in progressing from one strategy to
28 another, and the resulting impact on the development of the CLSC. The literature review has indicated
29 that pollution prevention and product stewardship are key, but potentially isolated components of the
30 CLSC, while a sustainability strategy can represent a complete closed loop response.

31 32 33 *The Research Framework*

34
35 The NRBV provides an appropriate structure for understanding the different CLSC practices that have
36 been presented and discussed in the literature review, to include the potential sequence or priority of their
37 implementation, the nature and extent of their interaction, and how this then combines to achieving the
38 fully coordinated CLSC illustrated in Figure 1. Its implicit recognition of strategic resources, both
39 tangible and intangible, and the need for stakeholder integration to achieve specific strategic capabilities
40 enables the role of supplier relationships to be evaluated as the CLSC develops. Figure 2 presents the
41 research framework that will be applied to address the following research questions:

42
43 RQ1. How does a focal firm implement and develop a CLSC response to environmental
44 sustainability?

45
46 RQ2. How do supplier relationships and resources contribute to the focal firm achieving a CLSC
47 response?

48 49 50 **FIGURE 2 HERE**

51
52 The framework consolidates the key environmental and resource-based concepts presented in the
53 literature review; it is used to analyse a firm's progress from each NRBV strategic capability, and how it
54 can use this path dependent approach to achieve a fully coordinated CLSC. The role of different forms of
55 resources associated with the NRBV are used to evaluate the contribution made by the firm and its

supplier relationships in achieving each stage.

Research Methodology

The clothing industry has been heavily researched in relation to global supply chains and therefore has an important contribution to make to the developing CLSC research field. It can be seen as an extreme case for managing environmental sustainability due to frequent shifts in product portfolio and its internationally organized product chains that substantially influence and extend the stages where environmental impacts can occur. Production processes in the clothing supply chain make intense use of chemical products and natural resources, creating emissions and waste and generating a high environmental impact (Fletcher, 2008). There is also a 'throwaway' attitude to clothing, due to increased purchase frequency and substantial pricing reductions (Birtwistle & Moore, 2007), which has resulted in an increased rate of garment disposal (Allwood et al., 2006), a key consideration within the CLSC.

Given its complexity and global nature translating the CLSC model into supply chains is a key challenge for the UK clothing industry, but there are signs that re-use and recycling are becoming sources of added value in supply chains (Fletcher, 2008). Recycling and reuse are proactive responses and have a positive impact on a product's lifecycle as well as addressing resource availability, especially important as virgin resources become scarcer (Sarkis et al., 2010a). The literature has indicated the importance of collaborative relationships in the CLSC, but the UK clothing industry has traditionally been highly transactional in nature, and focused on achieving lowest unit cost, primarily through sourcing from developing countries where labour is cheaper, even if this has negative environmental and social implications (Bruce et al., 2004). The industry therefore has specific relevance for this research study as it enables insight and understanding of how the focal firm can progress from an established and ingrained transactional model to one that enables a coordinated, collaborative and environmentally sustainable supply chain.

The presented case study is representative of exemplar UK clothing firms who operate responsibly and have owner-managers with strong environmental principles (Tilley, 1999). Such case study observations are well suited to relatively new research topics, especially where the phenomena are poorly understood (McCarthy et al., 2006); in-depth qualitative case studies are deeply embedded in rich empirical descriptions, and typically address 'how' and 'why' questions (Eisenhardt & Graebner, 2007). The methodology is particularly strong in theory building and appropriate to researching a dynamic, evolving phenomenon such as CLSCs (Eisenhardt & Graebner, 2007). Case studies offer high validity with practitioners (Karlsson, 2009) and the strategy provides powerful tools for capturing both the hard and soft elements of an organisation (Voss et al. 2002). While a single case offers limited generalizability, it can richly describe the existence of a phenomenon (Siggelkow, 2007), and provide the opportunity to develop a deep understanding of its nature and complexity in a specific setting (Barratt & Barratt, 2011).

Data Collection and Analysis

The main instrumentation for the data collection was the semi-structured interview (Miles & Huberman, 1994) with the key informants being the firm owner and the supply chain manager. An interview protocol was provided (Appendix 1) and a set of standard questions established that were adapted in response to any new or interesting facets that arose during the interview process (Reuter et al., 2010). Six visits were conducted over a 15-month period, as illustrated in Table 2, and 2 interviews had already been conducted with the firm a year previously. On-site interviews were also conducted with a key UK supplier and their Japan supplier. For purposes of internal validity, evidence was obtained from multiple sources: field notes

1
2
3 were recorded during each visit, and written supporting data obtained including Company Accounts,
4 marketing material and policies (Poba-Nzao et al., 2014). The secondary data collection extended beyond
5 the interview period (Table 2), and together with the interview transcripts this data formed a clear
6 narrative for the case (Yin, 2009).
7
8

9 **TABLE 2 HERE**

10 Qualitative data is full, earthy, holistic and real, but because the context is part of the study there will
11 always be many variables and a high volume of rich data (Yin, 2009). Cross interview analysis allowed
12 common patterns to be identified (Reuter et al., 2010), and a coding scheme (Charmaz, 2006; Strauss &
13 Corbin, 2008) was implemented to relate interview content to specific themes. It involved the systematic
14 and iterative review of each transcript and the extraction of recurrent data, which was then assigned to an
15 initial theme. The analysis process was guided by the reviewed literature, but new recurrent themes were
16 also identified - see Appendix 2 for the themes that resulted from the analysis and coding process.
17

18 Supporting information was used to verify, triangulate and enhance the data analysis (Karlsson, 2009),
19 and the longitudinal nature of the study enabled the development of the focal firm's supply chain to be
20 evaluated over a specific period of time. There is a recognized lack of longitudinal studies in the supply
21 chain literature, which typically looks at networks at a point in time rather than as a dynamic cycle
22 (Pilbeam et al., 2012). There is also recognition that the roles and responsibilities of a focal firm's
23 suppliers can change over time and as relationships evolve (Slepnirov et al., 2010), which is key to this
24 paper in understanding the importance of socially complex resources in achieving CLSCs. The
25 longitudinal study was conducted over a total period of just over 2 years, which was sufficient time to
26 build a rapport with the focal firm and interviewees, and to observe key developments in the firm's CLSC
27 and its relationships with suppliers (Aloini et al., 2015; Done et al., 2011, Eltantawy et al., 2015).
28

29 The case study is a surfing lifestyle brand based in the South West of the UK, and since being
30 established in 2005 it has grown in both size and turnover, as shown in Table 3). It has 3 explicit points of
31 commitment - People, Product and Planet. It specialises in making a select range of performance clothing
32 from recycled or natural fibres, and at the heart of the company ethos is a desire to make the best
33 technical apparel with minimal environmental impact, backed by a sustainable design philosophy.
34
35

36 **TABLE 3 HERE**

37 It will not manufacture products that cause more of a problem than they solve, and strives to
38 communicate the firm's honesty and trustworthiness to its suppliers, as well as its customers. The firm
39 has a strong and distinctive brand identity that directly aligns with its environmental principles, and a
40 loyal customer base; it aims to tell a story about its products and *'hope that our honesty comes out in our*
41 *marketing and people will learn to trust that'* (Owner). The firm sources environmentally responsible
42 materials, processes and suppliers, and as illustrated in Table 3 all products are designed in-house, along
43 with all customer facing activities.
44
45

46 **Research Findings**

47 *Principles*

48 Coming from a marine science and surfing background the owner has emotional connections to the
49 environment, which inform the principles that are applied to the firm and its supply chain. Strong beliefs
50 and values are likely to be associated with a founder (Pedersen, 2009), with business not just seen as an
51 income stream, but as a vehicle for change (Rodgers, 2010). This highlights the importance of
52
53
54
55
56
57

1
2
3 embeddedness, which directly relates to an organization's principles and culture; the studied firm was
4 established on the specific principles of People, Product and Planet, and these commitments permeate
5 their supply chain.

6
7 They aim to work with suppliers that share their principles, as this makes it easier to make the
8 appropriate environmental decisions. This was reflected in the supplier interviews; the Japan supplier is
9 the industry leader in recycled polyester and was established to address the environmental issues
10 associated with this oil-based fibre, while the UK supplier has a shared commitment to localized supply
11 of natural resources. The latter relationship indicates how their principles have evolved to inform a desire
12 for more local supply chains, as a mechanism to support UK/European producers and their local
13 community, reduce environmental impacts associated with global transport, and provide more supply
14 chain visibility. The firm also extends beyond traditional supply chain boundaries to align with customers
15 that share their values; loyalty to the firm's brand identity supports a strong supply chain and is a key
16 factor to closing the loop as it incentivizes RL. This theme reflects both the stakeholder integration and
17 shared vision dimensions of the NRBV (Table 1), and indicates how fundamental shared principles are as
18 a foundation to a coordinated CLSC.

21 *Pollution Prevention*

22
23 The studied firm has always looked to minimise the environmental impact of the products they design and
24 produce in their supply chain. They engage in environmentally-responsible manufacturing processes,
25 which requires working with suppliers that can meet these standards, and actively maximise the use of
26 their materials and components to ensure that minimal waste is generated and stays within the supply
27 chain. An example of this is the use of fabric offcuts from the production of their clothing products to
28 create a range of bags, and also as a source of material for the repair of returned products.

29
30 The longitudinal analysis indicates that this approach has always been integral to how they operate
31 their business and supply chain rather than a distinct strategy for environmental sustainability. This is in
32 contrast to the reviewed literature, which suggests internal pollution prevention activities such as waste
33 management are the dominant response to the environment in industry practice. This finding also
34 challenges the path dependent nature of the NRBV framework where firms engage in pollution prevention
35 as a starting point for environmental sustainability.

38 *Product Design*

39
40 The design process starts at the fibre stage and the firm flexes creative control through to how the finished
41 product can be maintained, repaired, reused, recycled, and disposed. It is in full control of the design
42 function and applies a DfE approach; for the principle of Planet this translates into sourcing and
43 developing raw materials derived from recycled, animal-friendly, or easily renewable origins; this
44 includes recycled polyester (an oil-based fibre) and Merino wool, which is a specific technical
45 requirement for its core base layers. These decisions enable them to create a Product which is durable,
46 repeatedly usable, harmlessly recoverable and environmentally compatible in disposal (Tsoufas &
47 Pappis, 2006).

48
49 The firm is directly engaged with the raw material purchasing stage and this extends to developing
50 their own performance fabrics; they explicitly look to improve their products, working collaboratively
51 with their key suppliers to develop the most environmentally responsible materials. This innovative use of
52 physical capital i.e. materials, and the harnessing of the tacit skills and expertise of its supply chain
53 partners creates a 'distinctive visibility' and competitive advantage that cannot be easily replicated by
54 competitors. The reviewed literature emphasised the role of the design function in the CLSC in enabling
55
56
57
58
59
60

1
2
3 key practices such as recycling and remanufacturing, and it clearly underpins the firm's strong product
4 stewardship approach.
5

6 *Product Stewardship*

7 The firm's Product principle translates into how it addresses each stage of a product's manufacture and
8 disposal. It believes that clothing firms have a responsibility for a product along its entire lifecycle; this
9 translates into their explicit 'cradle to cradle' approach which enables their customers to return garments
10 for repair, reuse and recycling. They consider that garments should be kept and maintained for as long as
11 possible, and product design and manufacture need to contribute to this. The firm applies a strong focus
12 on product performance and longevity that aligns with their environmental principles, and also represents
13 a key component of the CLSC;
14

15
16 *"We want to go back to making the kind of jacket your dad still has after 30 years... We don't want
17 that cycle where you get rid of stuff quickly. We want people to keep our stuff for a long time."*

18 (Owner).

19 Their aim is to minimize their environmental burden, in line with the third strategic capability of the
20 NRBV, and also educate the consumer to do the same, so they provide care and disposal information via
21 the products themselves and online channels. They innovate wherever possible throughout their supply
22 chain, and 'have a thirst for knowledge to improve our garments'; this suggests a drive for continuous
23 improvement in all aspects of the supply chain, rather than just pollution prevention as presented in the
24 NRBV framework. For them environmental sustainability is about change, adaptability and survival, and
25 its active engagement with suppliers, customers and community evidences the stakeholder integration
26 required by the NRBV to achieve a product stewardship capability.
27

28 *Closing the Loop*

29
30 The firm applies the CLSC model as illustrated in Figure 3; it incorporates all key clothing supply chain
31 stages, but also explicitly recognises the design function and the consumer's role in closing the loop,
32 stages that are excluded in the current CLSC model presented in Figure 1. While recycling and reuse
33 close the manufacturing loop, the design function is key to making responsible and sustainable decisions
34 *before* the process begins, and enabling effective closed loop practices such as recycling. The consumer's
35 role is multi-faceted as they are responsible for the product use, its care and disposal; responsible product
36 disposal is recognised as often the biggest contribution that can be made to environmental sustainability
37 (Das & Posinasetti, 2015), but is the aspect over which firms typically have the least control.
38
39
40

41 **FIGURE 3 HERE**

42
43 The longitudinal analysis indicated that the firm has always aimed to solve the challenge of product
44 disposal within its supply chain, and it actively addresses the issue through its repair and return service,
45 which has been available since it was established. The materials and components of returned products
46 which are at the end of their use can be recycled back into raw materials; recycled fibre represents a low-
47 impact alternative to other sources, with reduced energy and resource consumption as well as chemical
48 consumption if it is not over-dyed (Fletcher, 2008). The findings show that the studied firm has always
49 produced their outerwear from recycled polyester, for both performance and environmental purposes,
50 working with the leading industry fibre supplier; based in Japan they developed the closed loop
51 technology that enables 100% polyester garments, materials or components to be recycled into fibre.
52

53 While only polyester products can currently be returned to the Japan supplier for recycling into fibre,
54 the firm offers a repair service for their entire product range, which forms its own closed loop within the
55
56
57

1
2
3 supply chain (Kusumastuti et al., 2008). The repair service is performed in-house and aligns with the
4 firm's belief in product longevity through ensuring the longest possible life for their garments, but also
5 offers a mechanism for gaining insight into their products' performance and durability in the field, which
6 in turn enhances and develops their product stewardship approach. The literature review highlighted that
7 this CLSC practice is currently underrepresented in both research and practice, but represents a highly
8 relevant component of product stewardship. This finding reflects how the firm has successfully integrated
9 a key stakeholder into the supply chain, and the positive impact that customer loyalty and shared
10 principles has in closing the loop.
11
12

13 *Relationships and Resources*

14 The firm has always acknowledged the importance of good relationships and explicitly recognises the
15 need for the relational resource of trust in their supplier relationships; *'It's not a case of relying on them,*
16 *but trusting them. It's about having really good relationships with whoever we're working with, that*
17 *there's transparency and we understand what is required from each other'* (Supply Chain Manager). The
18 NRBV emphasises the need for shared principles and visions with key stakeholders to progress from
19 pollution prevention to a future-facing sustainability strategy. The firm's embedded and active
20 engagement with its suppliers, customers and community indicates that it has always been well-
21 positioned to reach this stage of the NRBV, and that suppliers are key in fully achieving a CLSC through
22 supporting and connecting each stage.
23
24

25 The long-term perspective that the firm applies brings additional benefits, with some of their suppliers
26 willing to accept lower profit margins because they trust, believe and share in the firm's sustainability
27 vision. The shared commitment is also evidenced in supplier flexibility and reciprocity with a desire to
28 provide solutions and solve problems for the firm. *'I know they haven't made any money on a certain*
29 *product because of the amount of development and delivery costs... they don't whinge about it because*
30 *they see it as a long-term relationship'* (Owner). This further emphasises the role of trust and reciprocity
31 as socially complex resources, and illustrates the strategic benefits of collaborative relationships. The UK
32 supplier interview also presented the related relational theme of 'brotherhood', indicating that despite the
33 growth in outsourcing to overseas suppliers there is a strong textile heritage and passion in the UK
34 industry that can be harnessed and developed in the CLSC.
35
36

37 While they currently source key materials from overseas suppliers (Table 3) the longitudinal analysis
38 revealed there has always been a desire for the supply chain to be closer to home, to more fully respond to
39 their environmental commitments, and minimise their environmental burden. A key example is the
40 innovative and inimitable Merino wool initiative; in 2008 the firm identified a UK farmer with the
41 necessary connections, knowledge and expertise, which could combine with its own technical and design
42 skills, and then embarked on a *very* long-term collaborative partnership. The farmer located the only
43 remaining breed of sheep in the UK that could produce the required high quality of wool, and developed a
44 breeding programme to establish production-level numbers, a stage that was achieved during the
45 longitudinal study. It highlights how the firm continuously strives to make their products and what they
46 do better, further illustrating that CI is not limited to pollution prevention, and how they collaboratively
47 engage their suppliers in the process to harness both physical and tacit resources.
48
49
50

51 **Discussion**

52 This paper has provided unique and rich insight into the environmental principles, practices, strategic
53 resources and relationships of an exemplar UK clothing firm, and how these different dimensions have
54 informed and developed their CLSC as a response to environmental sustainability. The application of the
55
56
57

1
2
3 NRBV research framework (Figure 3) has shown that the case study's supply chain relies strongly on
4 supplier collaboration and embedded environmental principles, and it has always taken a proactive,
5 product stewardship-based approach to environmental sustainability. The UK clothing industry is a very
6 relevant area for study, often representing an extreme example of poor environmental and social
7 responsibility, and has historically operated highly transactional and poorly coordinated supply chains.
8 This exemplar case study illustrates that these barriers and challenges can be addressed in the clothing
9 industry through the implementation of coordinated environmental practices and collaborative supplier
10 relationships, and has implications for CLSC design and practice in similarly complex and cost-driven
11 industries and where environmental sustainability is of growing importance.

12
13
14 RQ1. How does a focal firm implement and develop a CLSC response to environmental
15 sustainability?

16
17 The reviewed literature highlighted the growing imperative for addressing the environment in supply
18 chains, and presented the recognized mechanisms to do so (Das & Posinasetti, 2015) to include emissions
19 reduction, waste management, recycling, reuse and remanufacturing. The CLSC is of key importance to
20 environmental sustainability as it aims to integrate these activities to minimize environmental impact and
21 maximize value creation (Guide & Van Wassenhove, 2009), and the NRBV provides a 3 stage framework
22 for understanding how a focal firm can progress from internal pollution prevention activities to a
23 sustainability strategy. The findings indicate that the studied clothing firm's key motivations for
24 implementing a CLSC came from the founder's strong environmental principles and People, Product and
25 Planet sustainability vision. Clear, well-communicated environmental commitments therefore translated
26 into a strong and embedded organizational culture and brand identity that helped to prevent any
27 significant compromises in developing their CLSC.

28
29 As illustrated in the literature DfE represents a key starting point for developing a CLSC as it ensures
30 that environmental responsibility is built into the product itself, and subsequently encourages the right
31 decisions and practices to address environmental sustainability within the clothing supply chain. It is not
32 explicitly incorporated in the current CLSC model, but as the case study has indicated it has a vital role in
33 achieving a product stewardship strategy, and ensuring the effective implementation of the documented
34 recycling practices; without this product design consideration, the extent of the firm's response to
35 environmental issues will be constrained. The case study firm applies many of the key environmental
36 practices outlined in the literature review, including the innovative use of waste materials to create new
37 clothing products, use of recycled materials in product design and manufacture, and the repair, reuse and
38 recycling of returned products. It reflects its strong and continued product stewardship approach, and its
39 strong environmental principles underpin this, but the findings also show the importance of engaging and
40 integrating key stakeholders to achieve a CLSC. Suppliers could be considered the most important
41 stakeholder, and the case study evidences how effectively the firm has integrated them, but it also
42 indicates the key role of customers in ensuring that clothing products are returned into the loop for
43 recycling, reuse and repair.

44
45 The NRBV provides 3 path dependent strategies to guide a firm's progress from pollution prevention
46 to sustainability, and there is evidence of alignment between these strategies and the studied firm's supply
47 chain practices. However, the findings suggest that these strategies are not necessarily as sequential as
48 indicated in the current model, and challenges the role and relevance of pollution prevention as an explicit
49 stage in the CLSC. Pollution prevention, through its minimization of waste and use of 'green' production
50 processes is a core component of the case study's product stewardship approach, and the findings have
51
52
53
54
55
56
57
58
59
60

also indicated that the CI resource associated with pollution prevention applies to all aspects of the firm's CLSC. This therefore suggests that there are aspects of the 3 strategies that can develop concurrently and that pollution prevention is not necessarily the most appropriate starting point for developing a CLSC, as it is more reactive in nature and the extent of its impact on environmental sustainability is constrained.

RQ2. How do supplier relationships and different resources contribute to a focal firm achieving a CLSC response?

The presented findings illustrate the importance of strong, long-term, and trustful supplier relationships in achieving sustainability principles and commitments, as articulated in the reviewed literature (Ostlin et al., 2008). A collaborative rather than the more transactional approach typically associated with clothing supply chains means that different supply chain stages are coordinated efficiently and effectively, and appropriate environmental practices developed and implemented. Information, tacit skills, expertise and understanding are also shared, contributing to the firm's strategic resources, and the trust and shared principles with suppliers translates into flexibility and reciprocity that supports their commitment to CI in all aspects, and the ability to dynamically evolve the supply chain. These relationships in turn contribute to the socially complex resources that a firm can harness in its supply chain, and provide the sustainable competitive advantage advocated by the NRBV.

TABLE 4 HERE

Table 4 summarises the firm's physical, tacit and socially complex resources, resources that have enabled the firm to be proactive and value-seeking in its supply chain decisions. These resources have been integral to its product stewardship philosophy, initially in enabling the right materials, products and processes to be developed, and then ensuring that tacit skills and expertise can develop over time and that a sustainability culture and strategy is embedded in the CLSC. Further emphasising the importance of the design function for CLSCs, the firm has been involved in product development from the start, and this has evolved into the creation of proprietary performance fabrics. This control of a key supply chain stage develops strategic resources; the fabrics they have developed are core to their brand and product performance, and difficult for competitors to replicate, while the Merino-quality wool collaboration represents a very rare, valuable and inimitable resource. This is due to the limited availability of the material, but also the more tacit shared skills, vision and commitment of the supply partner.

The firm currently has control of 95% of their textiles, garment development and manufacturing. This level of control and visibility has enabled them to ask important questions in line with their points of commitment, and illuminate all areas of the supply chain. Its strong, trustful, collaborative and often personal supplier relationships allow them to track their tangible environmental achievements and share information and visibility of the whole supply chain with its customers; as the findings have illustrated these represent key stakeholders and should be integrated into the CLSC. The studied firm does have strong connections with its customer base, but could more fully harness them to achieve the same level of control it has within the design and manufacturing functions, and therefore ensure a reliable and manageable flow of returned products. This could be achieved by developing their business model to become a service rather than product provider, engaging in contractual relationships with their customers that would require on-going monitoring and modification of the product (Sundin & Bras, 2005).

Shared environmental principles between firm and supplier, and also customers, make product stewardship possible in the immediate term, but more importantly it is this strong foundation and the relationships that evolve as a result that enable them to progress further; the extent to which a shared vision and commitment becomes embedded over time ensures that a sustainability strategy and fully

1
2
3 coordinated CLSC can be achieved.
4

5 **Conclusion, limitations and future research**

6 This paper builds on CLSC research that is taking a more integrated approach to understanding
7 environmental principles, value creation and relationships in global supply chains (Miemczyk et al.,
8 2016), and applies an NRBV framework to the UK clothing industry where environmental sustainability
9 is of critical importance. CLSCs are recognised as a significantly important mechanism to address
10 environmental sustainability (Crandall, 2006), but have not been broadly researched or developed to date
11 (Kumar and Putnam, 2008). There is an acknowledged need for practitioner tools in the field (Das and
12 Posinasetti, 2015), and the global and complex nature of the clothing industry strongly reflects the key
13 challenges of CLSC implementation. The ‘greening’ of products and processes is a dominant metaphor in
14 current research and practice (Vachon & Klassen, 2006), but this focus on pollution prevention limits the
15 CLSC response, and lacks the embeddedness required for achieving a sustainability strategy. Pollution
16 prevention is a reactive approach to environmental sustainability, but the case study has shown that it
17 does not have to be the initial response to environmental sustainability, and more importantly that CLSCs
18 are not just the tangible implementation of environmentally responsible practices.
19

20
21
22 The paper illustrates the applicability of the NRBV framework for developing CLSC research from
23 this dominant practice-based response to a much-needed holistic perspective, that more fully integrates
24 environmental and social considerations in the supply chain (Ashby et al., 2012), and highlights the role
25 of tacit resources, shared principles/visions, and socially complex relationships in enabling sustainability
26 principles to be *embedded*. As demonstrated by the studied firm this embeddedness and a long-term,
27 perspective means the environment is incorporated into every supply chain stage, from design to disposal,
28 and enables the most appropriate CLSC decisions to be made. The findings evidence that the CLSC
29 requires strong environmental foundations, but that it is also a dynamic and evolving entity; the
30 longitudinal analysis revealed the firm’s progressive change from its Japan polyester supplier to one in
31 Europe, and how its embedded and shared principles minimised its impact on the supply chain.
32

33
34 The findings indicated a need to extend the CLSC model to explicitly integrate the design function and
35 the end customer, as these will ensure that appropriate environmental activities can be implemented
36 effectively. The studied firm’s strong and committed focus on product design and performance provides
37 practitioners with a more appropriate starting point for the CLSC, as it ensures that the environment is
38 ‘built in’ to the product and subsequent supply chain stages, rather than just implementing pollution
39 prevention activities. This product stewardship approach ensures that practitioners recognise the
40 importance of integrating key stakeholders in the CLSC, and how these relationships can develop to help
41 minimise the environmental burden of the supply chain. The case study illustrates it is more
42 straightforward to take control of the design function, but that a successful strategy will rely on
43 developing connections with the end customer. A strong brand, product identity and shared principles will
44 form the foundation of these connections, and could enable more functional sales mechanisms such as a
45 customer contract based on service (Sundin & Bras, 2005). This would enable the focal firm to monitor
46 and develop product performance and ensure the maximum possible return of products.
47

48
49
50 The path dependent process proposed by the NRBV, while aligned to the CLSC model is not
51 necessarily the most effective approach, and for researchers this offers the opportunity to develop the
52 NRBV framework further within the CLSC field, and in multi-disciplinary and integrative
53 methodological directions (Ashby et al., 2012). Conceptually this requires a less linear framework where
54 pollution prevention is not considered strategic, as in the NRBV, but rather the operational norm. This
55 would remove the cost dimension, recognised as skewing sustainability responses (Seuring, 2008), and
56
57

emphasise tacit and socially complex resources. Strategies would then evolve from strong organisational principles rather than progression along a specific path, providing an individualised, embedded and proactive response to environmental sustainability. There is therefore a need to apply multiple theoretical lenses that can fully capture the organisational, intangible resources and relational aspects of this framework; Institutional, (Social) Network, Stakeholder and Social Capital theories offer this potential, but while employed in sustainability research they are typically used independent of each other.

The limitations of the paper are through its focus on a single case study, albeit one that has strong environmental principles that have driven its commitment to and development of a CLSC. The findings offer unique insights into the successful implementation of a CLSC, and the role played by strategic resources and stakeholder relationships, but they are not representative of the average clothing firm and therefore not generalizable to the clothing industry as a whole. There is therefore a need for multiple case studies of firms in the process of developing a CLSC to address environmental sustainability; to improve the generalisability of the findings CLSC practice in other firms and industries should be evaluated against the NRBV to develop a more dynamically interactive model than is currently presented.

References

- Albino, V., Balice, A. & Dangelico, R. M. (2009). Environmental Strategies and Green Product Development: an Overview on Sustainability-Driven Companies. *Business Strategy and the Environment*, 18, 83-96.
- Allwood, J.M., Laursen, S.E., Malvido de Rodriguez, C., & Bocken, N.M.P. (2006). Well-dressed? The present and future sustainability of clothing and textiles in the united kingdom. Cambridge: Biffaward Programme on Sustainable Resource Reuse, Institute for Manufacturing, University of Cambridge.
- Aloini, D., Dulmin, R., Mininno, V., Ponticelli, S., (2015). Key antecedents and practices for Supply Chain Management adoption in project contexts. *International Journal of Project Management*, 33, 1301–1316.
- Angell, L. C. & Klassen, R. D. (1999). Integrating environmental issues into the mainstream: an agenda for research in operations management. *Journal of Operations Management*, 17, 575-598.
- Ashby, Alison, Smith, Melanie Hudson, & Leat, Mike. (2012). Making connections: A review of supply chain management and sustainability literature. *Supply Chain Management: An International Journal*, 17(5), 497 - 516.
- Attaran, M., & Attaran, S. (2007). Collaborative supply chain management. *Business Process Management Journal*, 13(3), 390-404.
- Barney, Jay B. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.
- Barney, Jay B. (2012). Purchasing, supply chain management and sustained competitive advantage: The relevance of resource-based theory. *Journal of Supply Chain Management*, 48(2), 3-5.
- Barney, Jay B., & Hesterley, William S. (2008). *Strategic management and competitive advantage : Concepts and cases*: Pearson Education Inc.
- Barney, Jay B., Wright, Mike, & Ketchen Jr., David J. (2001). The resource-based view of the firm: Ten years after 1991. *Journal of Management*, 27, 625-641.
- Barratt, M., Barratt, R. (2011). Exploring internal and external supply chain linkages: Evidence from the field. *Journal of Operations Management*, 29, 514–528.
- Barrutia, J.M, Echebarria, C. (2015). Resource-based view of sustainability engagement. *Global Environmental Change*, 34, 70–82.
- Birtwistle, G., & Moore, C.M. (2007). Fashion clothing - where does it all end up? *International Journal of Retail and Distribution Management*, 35(3), 210-216.

- 1
2
3 Blumberg, Donald F. (2005). *Introduction to management of reverse logistics and closed loop supply*
4 *chain processes*: Taylor and Francis.
- 5 Bruce, Margaret, Daly, Lucy, & Towers, Neil. (2004). Lean or agile: A solution for supply chain
6 management in the textiles and clothing industry? *International Journal of Operations & Production*
7 *Management*, 24(2), 151-170.
- 8 Carter, C.R., & Ellram, Lisa M. (1998). Reverse logistics: A review of the literature and framework for
9 future investigation. *Journal of Business Logistics*, 19(1), 85-102.
- 10 Charmaz, Kathy. (2006). *Constructing grounded theory*: Sage Publications.
- 11 Crandall, Richard E. (2006). How green are your supply chains? *Industrial Management*, 48(3), 6-11.
- 12 Darnall, Nicole, Jolley, G. Jason, & Handfield, Robert B. (2008). Environmental management systems
13 and green supply chain management: Complements for sustainability? *Business Strategy and the*
14 *Environment*, 18, 30-45.
- 15 Das, Kanchan, & Posinasetti, Nageswara Rao. (2015). Addressing environmental concerns in closed loop
16 supply chain design and planning. *International Journal of Production Economics*, 163, 34-47.
- 17 Defee, C. Clifford, Esper, Terry, & Mollenkopf, Diane. (2009). Leveraging closed-loop orientation and
18 leadership for environmental sustainability. *Supply Chain Management: An International Journal*, 14(2),
19 87-98.
- 20 Done, A., Voss, C., Gorm Rytter, N.G., (2011). Best practice interventions: Short-term impact and long-
21 term outcomes. *Journal of Operations Management*, 29, 500–513.
- 22 Eisenhardt, Kathleen M., & Graebner, Melissa E. (2007). Theory building from case: Opportunities and
23 challenges. *Academy of Management Journal*, 50(1), 25-32.
- 24 Elia, Valerio, & Gnoni, Maria Grazia. (2015). Designing an effective closed loop system for pallet
25 management. *International Journal of Production Economics*, 170, 730-740.
- 26 Eltantawy, R., Paulraj, A., Giunipero, L., Naslund, D., Thute, A.A., (2015). Towards supply chain
27 coordination and productivity in a three echelon supply chain: Action research study. *International*
28 *Journal of Operations & Production Management*, 35(6), 895-924.
- 29 Field, Joy M., & Sroufe, Robert P. (2007). The use of recycled materials in manufacturing: Implications
30 for supply chain management and operations strategy. *International Journal of Production Research*, 45,
31 (18/19).
- 32 Fletcher, Kate. (2008). *Sustainable fashion and textiles*: Earthscan.
- 33 Fletcher, Kate, & Grose, Lynda. (2012). *Fashion and sustainability*. London: Laurence King Publishing
34 Ltd.
- 35 Florida, Richard. (1996). Lean and green: The move to environmentally conscious manufacturing.
36 *California Management Review*, 39,(1), 80-105.
- 37 Grekova, K., Bremmers, H.J., Trienekens, J.H., Kemp, R.G.M, Omta, S.W.F. (2014). Extending
38 environmental management beyond the firm boundaries: An empirical study of Dutch food and beverage
39 firms. *International Journal of Production Economics* 152, 174–187
- 40 Guide, V. Daniel R., & Van Wassenhove, Luk N. (2009). The evolution of closed-loop supply chain
41 research. *Operations Research*, 57(1).
- 42 Gupta, Mahesh C. (1995). Environmental management and its impact on the operations function.
43 *International Journal of Operations & Production Management*, 15(8), 34-51.
- 44 Hart, Stuart L. (1995). A natural-resource-based view of the firm. *Academy of Management Review*,
45 20(4), 986-1014.
- 46 Hatcher, G.D., Ijomah, W.L., Windmill, J.F.C. (2011). Design for remanufacture: a literature review and
47 future research needs. *Journal of Cleaner Production*, 19, 2004-2104.
- 48 Hitt, M.A., Xu, K., Carnes, C.M., (2015). Resource based theory in operations management research.
49 *Journal of Operations Management*, 41, 77-94.
- 50 Jena, Sarat Kumar, & Sarmah, S.P. (2014). Price competition and co-operation in a duopoly closed-loop
51 supply chain. *International Journal of Production Economics*, 156, 346-360.
- 52 Karlsson, Christer. (2009). *Researching operations management*: Routledge.
- 53
54
55
56
57
58
59
60

- 1
2
3 Kenne, Jean-Pierre, Dejax, Pierre, & Gharbi, Ali. (2012). Production planning of a hybrid manufacturing-
4 remanufacturing system under uncertainty within a closed-loop supply chain. *International Journal of*
5 *Production Economics*, 135, 81-93.
- 6 Kerr, W. Ryan, C. (2001). Eco-efficiency gains from remanufacturing A case study of photocopier
7 remanufacturing at Fuji Xerox Australia. *Journal of Cleaner Production*, 9, 75–81
- 8 Kleindorfer, Paul R., Singhal, Kalyan, & Van Wassenhove, Luk N. (2005). Sustainable operations
9 management. *Production and Operations Management*, 14(4), 482-492.
- 10 Kumar, Sameer, & Putnam, Valora. (2008). Cradle to cradle: Reverse logistics strategies and
11 opportunities across three industry sectors. *International Journal of Production Economics*, 115(2), 305-
12 315.
- 13 Kusumastuti, Ratih Dyah, Piplani, Rajesh, & Lim, Geok Hian. (2008). Redesigning closed-loop service
14 network at a computer manufacturer: A case study. *International Journal of Production Economics*, 111,
15 244-260.
- 16 Lippman, Steve. (2001). Supply chain environmental management. *Environmental Quality Management*,
17 *Winter*, 11-14.
- 18 Mascle, Christian, & Zhao, Hong Ping. (2008). Integrating environmental consciousness in
19 product/process development based on life-cycle thinking. *International Journal of Production*
20 *Economics*, 112(1), 5-17.
- 21 Mena, C., Terry, L.A., Williams, A, Ellram, L. (2014). Causes of waste across multi-tier supply networks:
22 Cases in the UK food sector. *International Journal of Production Economics* 152, 144–158.
- 23 Miemczyk, Joe, Howard, Mickey & Johnsen, Thomas E. (2016). Dynamic development and execution
24 of closed-loop supply chains: a natural resource-based view. *Supply Chain Management: An International*
25 *Journal*, 21(4), 453-469
- 26 Miles, Matthew B., & Huberman, A.M. (1994). *Qualitative data analysis*: Sage Publications.
- 27 Min, Hokey, & Galle, William. (1997). Green purchasing strategies: Trends and implications.
28 *International Journal of Purchasing and Materials*, Summer, 10-17.
- 29 Neto, J. Quariguasi Frota, Walther, G., Bloemhof, J., Nunen, J.A.E.E. van, & Spengler, T. (2010). From
30 closed-loop to sustainable supply chains: The WEEE case. *International Journal of Production Research*,
31 48(15), 4463-4481.
- 32 New, Steve, & Westbrook, Roy. (2004). *Understanding supply chains: Concepts, critiques and future*:
33 Oxford University Press.
- 34 Nyaga, Gilbert N., Whipple, Judith M., & Lynch, Daniel F. (2010). Examining supply chain relationships:
35 Do buyer and supplier perspectives on collaborative relationships differ? *Journal of Operations*
36 *Management*, 28, 101-114.
- 37 O'Brien, Christopher. (1999). Sustainable production - a new paradigm for a new millennium.
38 *International Journal of Production Economics*, 60-61, 1-7.
- 39 Ostlin, Johan, Sundin, Erik, & Bjorkman, Mats. (2008). Importance of closed-loop supply chain
40 relationships for product remanufacturing. *International Journal of Production Economics*, 115, 336-348.
- 41 Pedersen, E. R. 2009. The many and the few: SMEs that manage CSR in the supply chain. *Supply Chain*
42 *Management: An International Journal*, 14, 109-116.
- 43 Pilbeam C, Alvarez G, Wilson H (2012). The governance of supply net- works: a systematic literature
44 review. *Supply Chain Management: An International Journal*, 17(4), 358–376.
- 45 Poba-Nzaou, P., Raymond, L., Fabi, B. (2014). Risk of adopting mission-critical OSS applications: an
46 interpretive case study. *International Journal of Operations & Production Management*, 34(4), 477-512.
- 47 Power, D. (2005). Supply chain management integration and implementation: A literature review. *Supply*
48 *Chain Management: An International Journal*, 10(2), 252-263.
- 49 Preuss, Lutz. (2005a). *The green multiplier: A study of environmental protection and the supply chain*:
50 Palgrave Macmillan.
- 51 Preuss, Lutz. (2005b). Rhetoric and reality of corporate greening: A view from the supply chain
52 management function. *Business Strategy and the Environment*, 14, 123-139.
- 53
54
55
56
57
58
59
60

- 1
2
3 Pun, Kit Fai. (2006). Determinants of environmentally responsible operations: A review. *International*
4 *Journal of Quality and Reliability Management*, 23(3), 279-297.
- 5 Rao, P., & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance?
6 *International Journal of Operations & Production Management*, 25(9), 898-916.
- 7 Reuter, Carsten, Foerstl, Kai, Hartmann, Evi, & Blome, Constantin. (2010). Sustainable global supplier
8 management: The role of dynamic capabilities in achieving competitive advantage. *Journal of Supply*
9 *Chain Management*, 46(2), 45-63.
- 10 Rodgers, C. 2010. Sustainable Entrepreneurship in SMEs: a case study analysis. *Corporate Social*
11 *Responsibility and Environmental Management*, 17, 125-132.
- 12 Rusinko, Cathy A. (2007). Green manufacturing: An evaluation of environmentally sustainable
13 manufacturing practices and their impact on competitive outcomes. *IEEE Transactions on Engineering*
14 *Management*, 54(3), 445-454.
- 15 Sarkis, Joseph. (1995). Manufacturing strategy and environmental consciousness. *Technovation*, 15(2),
16 79-97.
- 17 Sarkis, Joseph, Helms, Marilyn, M, & Hervani, Aref A. (2010a). Reverse logistics and social
18 sustainability. *Corporate Social Responsibility and Environmental Management*, 17, 337-354.
- 19 Sarkis, Joseph, Helms, Marilyn, M, & Hervani, Aref A. (2010b). Reverse logistics and social
20 sustainability. *Corporate Social Responsibility and Environmental Management*.
- 21 Seitz, M.A., & Peattie, K. (2004). Meeting the closed-loop challenge: The case of remanufacturing.
22 *California Management Review*, 42(2).
- 23 Slepnirov D, Waehrens BV, Jorgensen C (2010) Global operations net- works in motion: managing
24 configurations and capabilities. *Operations Management Research*, 3, 107–116.
- 25 Seuring, S. (2008). Assessing the rigor of case study research in supply chain management. *Supply Chain*
26 *Management: An International Journal*, 13(2), 128-137.
- 27 Seuring, S., Muller, M. (2008). Core issues in sustainable supply chain management: A delphi study.
28 *Business Strategy and the Environment*, 17, 455-466.
- 29 Siggelkow, N. (2007), Persuasion with case studies. *Academy of Management Journal*, 50, 1, 20-24.
- 30 Simpson, D.F., & Power, D. (2005). Use the supply relationship to develop lean and green suppliers.
31 *Supply Chain Management: An International Journal*, 10(1), 60-68.
- 32 Spekman, R.E., Kamauff Jr, J.W., & Myhr, N. (1998). An empirical investigation into supply chain
33 management: A perspective on partnerships. *Supply Chain Management*, 3(2), 53-67.
- 34 Strauss, Anselm, & Corbin, Juliet. (2008). *Basics of qualitative research*: Sage Publications.
- 35 Sundin, E., Lindahl, M., Ijomah, W. (2009). Product design for product/service systems: Design
36 experiences from Swedish industry, *Journal of Manufacturing Technology Management*, 20(1), 723-753.
- 37 Sundin, E., Bras, B. (2005). Making functional sales environmentally and economically beneficial
38 through product remanufacturing. *Journal of Cleaner Production* 13, 913-925.
- 39 Tilley, Fiona. (1999). The gap between the environmental attitudes and the environmental behaviorur of
40 small firms. *Business Strategy and the Environment*, 8, 238-248.
- 41 Tsoufas, G.T., & Pappis, C.P. (2006). Environmental principles applicable to supply chains design and
42 operation. *Journal of Cleaner Production*, 14, 1593-1602.
- 43 Vachon, S., & Klassen, Robert D. (2006). Green project partnership in the supply chain: The case of the
44 package printing industry. *Journal of Cleaner Production*, 14, 661-671.
- 45 Vachon, Stephan, & Klassen, Robert D. (2008). Environmental management and manufacturing
46 performance: The role of collaboration in the supply chain. *International Journal of Production*
47 *Economics*, 111(2), 299-315.
- 48 van Bommel HWM (2011) A conceptual framework for analyzing sustainability strategies in industrial
49 supply networks from an innovation perspective. *Journal of Cleaner Production* 19, 895–904.
- 50 Varma, S., Wadhwa, S., & Deshmukh, S, G. (2006). Implementing supply chain management in a firm:
51 Issues and remedies. *Asia Pacific Journal of Marketing and Logistics*, 18(3), 223-243.
- 52 Voss C, Tsikrikis N, Frohlich M (2002) Case research in operations management. *International Journal*
53
54
55
56
57

1
2
3 *of Operations Production Management*, 22, 195–219.

4 Wong, C.W.Y, Kee-hung Lai, Kuo-Chung Shang, Chin-Shan Lu, T.K.P. Leung. (2012). Green operations
5 and the moderating role of environmental management capability of suppliers on manufacturing firm
6 performance. *International Journal of Production Economics*, 140, 283–294.

7 Yin, Robert K. (2009). *Case study research: Design and methods*: Sage Publications.
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Appendix 1 – Interview Protocol

Context Area	Level	Questions	Field Procedures/ Sources of Information
Company Ethos	Organisation	What is your background? (each interviewee) What are the firm's sustainability principles? How are these communicated?	Interviews Company literature
Design	Product	Who is involved with the design of your products and why? How are design requirements communicated to the supply chain? How do you develop/evolve existing products?	Interviews Product specs/brochures
Raw Materials	Product	What raw materials do you use and why? Where do you source your raw materials and why?	Interviews Product specs/brochures
Garment Production	Process	Where are your finished products manufactured and why? How do you monitor and manage this stage of the process?	Interviews
Supplier relationships	Organisation/ suppliers	How do you manage your supplier relationships? How long have you been working with each supplier? Do you have policies/codes of practice in place with your suppliers and if so how do you ensure they are achieved? How important are your supply chain relationships to achieving your business and sustainability goals? How frequently do you change or source new suppliers?	Interviews with firm and its suppliers where feasible
Communication	Organisation/ suppliers	How do you communicate with your suppliers? How frequently? Who has direct communication with your suppliers and why?	Interviews Marketing material Direct observation
Decision making	Organisation	Who is involved in business decisions and why? How do you align your decisions with your firm ethos/principles?	Interviews
End of Life	Process	Do you have any mechanisms to allow customers to return products to you for repair/reuse/recycling? Do your suppliers provide any end of life options?	Interviews
Company Performance	Organisation	How many staff do you employ? What is your annual turnover? Are you profitable?	Annual reports/financial data

Appendix 2 – Themes from Analysis and Coding Process

Cross Interview Themes	
SME Characteristics	Home originated business
	High eco literacy
Supply chain practice	SCM understanding
	High levels of measurement (2)
	Unique processes
Supply chain configuration	European manufacturing
	Creation of new industry/supply chain
	UK produced, processed & manufactured (1)
	Local not necessarily ethical (1)
Supply chain relationships	Personal relationships
	Trust & transparency
	Innovation, adaptability, evolution
	Posterity & heritage (1)
Supply chain boundaries	Product lifecycle
	Closed loops (2)
Product	Longevity
	Functionality
	Customer informs product development
Principles	Integrity & honesty
	Product, planet, people
	Telling a story
	No compromise on quality (1)
	Cannot hurry nature (1)
	Preservation (1)
Financial/operational	Commerciality
	Buyer priorities - price over expertise (2)
	High street uncaring & unaware (2)
Social responsibility	Local charity
	Local community
	Textile brotherhood (1)
Key: 1 = UK supplier, 2 = Japan supplier	

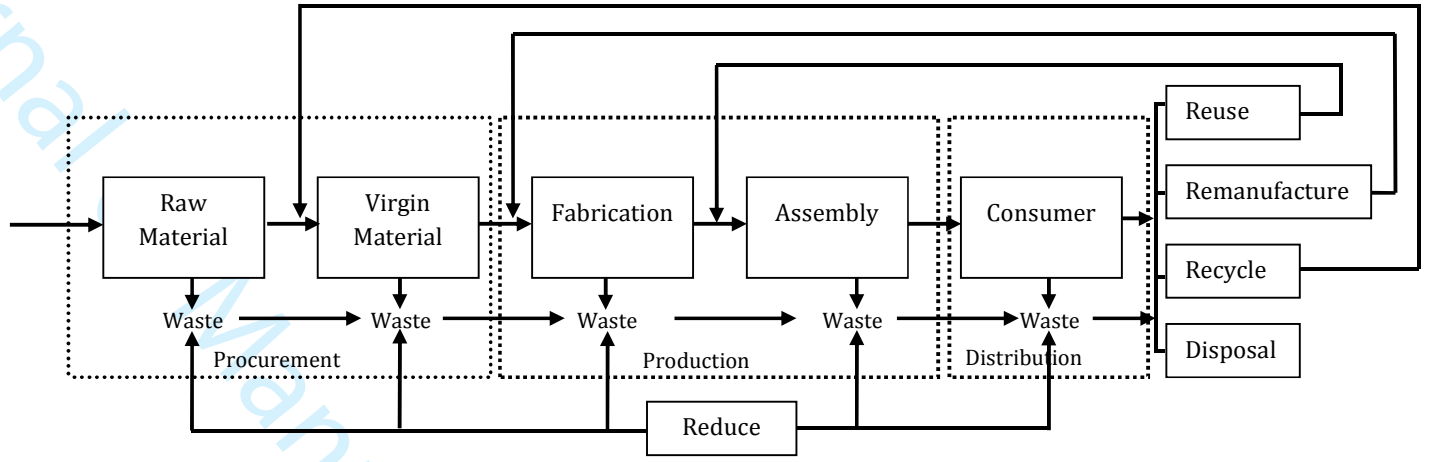


Figure 1: Closed Loop Supply Chain (CLSC) (Sarkis, 1995)

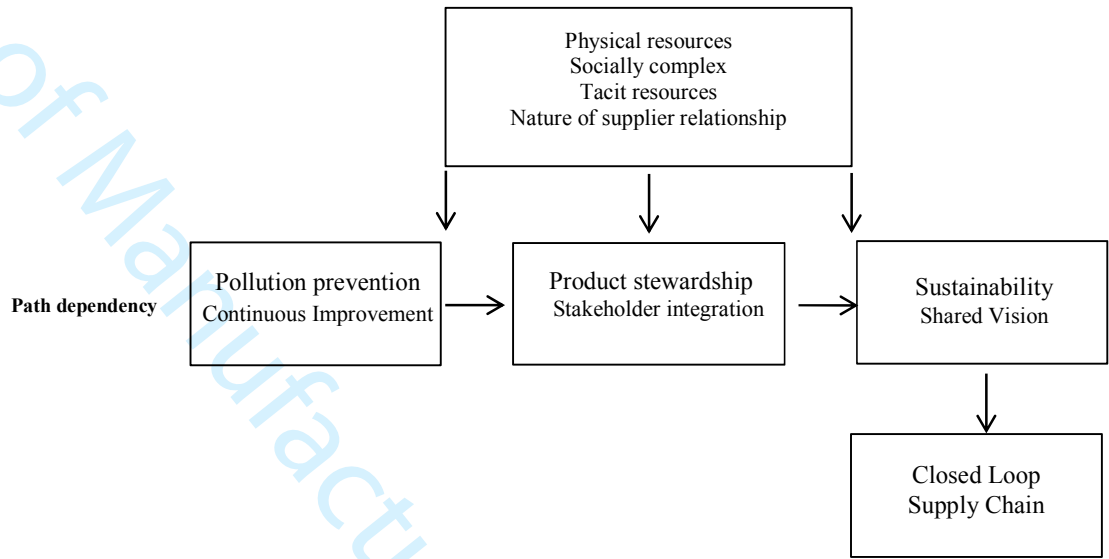


Figure 2: The Research Framework



Figure 3: The Closed Loop Model

Strategic Capability	Environmental Driving Force	Key Resource	Competitive Advantage
Pollution Prevention	Minimise emissions & waste	Continuous improvement	Lower costs
Product Stewardship	Minimise lifecycle cost of products	Stakeholder integration	Pre-empt competitors
Sustainability	Minimise environmental burden of firm growth & development	Shared vision	Future position

Table 1: Natural Resource Based View of the Firm (Hart, 1995)

Date	Duration	Interviewee	Location
13/4/10	41 mins	Firm Owner	Head Office, Cornwall
13 ⁴ /10	38 mins	Supply Chain Manager	Head Office, Cornwall
14/1/11	48 mins	Firm Owner	Head Office, Cornwall
10/3/11	1 hour 21 mins	Design Director	Head Office, Cornwall
23/6/11	59 mins	Supply Chain Manager	Head Office, Cornwall
18/10/11	45 mins	Japan Supplier – UK Manager	Head Office, London
18/11/11	1hour 15 mins	UK Supplier - Owner	Supplier premises, Devon
30/11/11	27 mins	Firm Owner	Head Office, Cornwall
6/3/12	34 mins	Supply Chain Manager	Head Office, Cornwall

Table 2: Interview Details

Established	2005
Turnover 2011/12	£668,000
Turnover 2014/15	£1.48M
No. of Employees	30
Accreditation	Global Organic Textile Standard (GOTS)
Sales Mechanisms	Independent retailers, own retail outlets, online sales
Supplier Locations	Australia, China, Japan, Portugal, Italy, UK
Core Products	Knitted base layers, waterproofs, insulation
In-house activities	Product design, marketing, warehousing & despatch, customer service, product repair

Table 3: Key Company Information

Physical Resources	Tacit Resources	Socially Complex Resources
Raw materials	Skills and expertise	Personal relationships/friendship
Own performance fabrics	Brand identity/story/loyalty	Shared vision and principles
Innovative developments	Principles	Trust and commitment
Product longevity	Reputation	Supply chain culture
Product recycling and	Firm culture	

Table 4: Case Study Firm's Strategic Resources