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**Supply Chain Learning of Sustainability in Multi-tier Supply
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A resource orchestration perspective**

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Supply Chain Learning of Sustainability in Multi-tier Supply Chains:
A resource orchestration perspective

Abstract

Purpose - The aim of the paper is to explore how multinational corporations (MNCs) orchestrate internal and external resources to help their multi-tier supply chains learn sustainability related knowledge.

Design/methodology/approach – An exploratory multiple case study approach was adopted and three MNCs’ sustainable initiatives in China were examined. The data were primarily collected through 43 semi-structured interviews with managers of focal companies and their multi-tier suppliers.

Findings - We found that in order to facilitate their supply chains to learn sustainability, MNCs tend to orchestrate in breadth by internally setting up new functional departments and externally working with third parties; and orchestrate in depth working directly with their extreme upstream suppliers adopting varied governance mechanisms on lower-tier suppliers along the project lifecycle. The resource orchestration in breadth and depth and along the project lifecycle results in changes of supply chain structure.

Practical implication – The proposed conceptual model provides an overall framework for companies to design and implement their multi-tier sustainable initiatives. Companies could learn from our suggested learning stages and the best practices of case companies.

Originality/value - We extend and enrich Resource Orchestration Perspective (ROP), which is internally focused, to a supply chain level; and answer a theoretical question of how MNCs orchestrate their internal and external resources to help their supply chains to learn sustainability. Our extension of ROP refutes the resource dependence theory, which adopts a passive approach of relying on external suppliers and proposes that MNCs should proactively work with internal and external stakeholders to learn sustainability.

Keywords: Supply chain learning; Multi-tier supply chain; Resource orchestration; Supplier governance mechanisms; Sustainability; case study

Paper Classification: Research paper

1. Introduction

In the last decade, Sustainable Supply Chain Management (SSCM) has drawn much attention from both industry and academia alike. Organizations review their products and processes to deliver more environmental friendly products and services and also to pay attention to the social aspects of sustainability such as health and safety and community programs (Huq *et al.*, 2016). The hot debate on this subject can be identified by dozens of literature reviews on SSCM (Seuring and Muller, 2008; Sarkis *et al.*, 2011; Gimenez and Tachizawa, 2012; Miemczyk *et al.*, 2012; Touboulic and Walker, 2015).

The research interest in SSCM has gradually shifted in the past few years from focusing on focal companies to Tier 1 suppliers (Wilhelm *et al.*, 2016) to sub suppliers (Grimm *et al.*, 2014) at a multi-tier supply chain level (Mena *et al.* 2013; Tachizawa and Wong, 2014). However, among these studies, very few focus on how sustainability knowledge is learnt in the supply chain, although supply chain learning (SCL) is believed to be conducive to win supply chain competitive advantages (Bessant *et al.*, 2003). Little empirical work has been conducted on learning even at a dyadic level (buyer-supplier) after Bessant *et al.* (2003) (Jia and Lamming, 2013; Zhu *et al.*, 2017 forthcoming), let alone SCL of sustainability in multi-tiers (Biotto *et al.*, 2012; Silvestre, 2015; Gosling *et al.*, 2016).

In practice, SCL in multi-tier supply chains has become increasingly important. Ivarsson and Alvstam (2009) provide a case of Volvo's work with its first-tier suppliers, in which Volvo disseminated quality management and supply chain management (SCM) to sub-tier Chinese suppliers benefiting all members of the chain. Tang (2008) provides Mattel's recall case: the fact that Mattel's first-tier supplier had not disseminated the learning of quality control to sub-tier suppliers was the main reason for the recalls of millions of toys, resulting in significant loss in market shares and reputation for Mattel in 2007.

In this study, building on the Resource Orchestration Perspective (ROP) (Sirmon *et al.*, 2007; 2011), we carried out multiple case studies focusing on multinational corporations' (MNC) sustainable practices in China. China is considered the 'factory of the world' (Harney, 2008) and is still one of the most rapidly developing centres of production in the world (Biggermann and Fam, 2011). On the other hand, China is facing various sustainability issues, as it has been the 'largest carbon emission country' and 'largest energy consumer country' around the globe (Chinese Academy of Sciences, 2012). In this research, we attempt to explore the following research question:

How do MNCs orchestrate resources and make their supply chain partners learn sustainability knowledge in multi-tier supply chains?

To answer the above research question, we attempt to draw insights from emerging areas of research in SCM to build a theory of SCL in multi-tier SSCM. This research contributes to the SCM literature in the following ways: first, it may be the first attempt to study SSCM through a SCL lens and adopt a process review; second, we may be the first to investigate SCL in multi-tier supply chains adopting the ROP; third ROP is extended to a supply chain level along three dimensions of breadth, depth and project lifecycle.

The rest of the paper is structured as follow. Section two provides a literature review of multi-tier SSCM, SCL and ROP; section three presents the case research method followed by a presentation of the case description of the three cases in section four; cross case analysis of the three cases regarding the similarities and differences is carried out in section five; section six discusses the case findings against the reviewed literature and develops a conceptual framework and a number of propositions. Finally, section seven summarizes theoretical and practical contributions and acknowledges limitations of this research.

2. Literature review

2.1 Multi-tier SSCM

SSCM has been defined by Seuring and Muller (2008, 1700) as: *“The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements.”* The definition focuses on three inputs in the supply chain and three aspects of sustainability. It also emphasises *“cooperation among companies along the supply chain”*; thus sustainability is not considered only for focal companies, but rather for the whole supply chain of a multi-tier system. We adopt this definition in our study with the emphasis on the whole chain of multi-tier suppliers.

There are two streams of research that have been discussed in multi-tier SSCM. One stream on multi-tier SSCM discusses the implementation of code of conducts or standards such as ISO14001, SA 8000 (Mueller *et al.*, 2009; Orzes *et al.*, 2017); WEEE (Waste Electrical and Electronic Equipment) and RoHS (Restriction of the use of certain Hazardous substances) (Koh *et al.*, 2012); and the application of due diligence on conflict minerals (Hofmann *et al.*, 2015). Recently, Wilhelm *et al.* (2016) discuss the double-agency role played by the first-tier suppliers in managing sustainability in three-tier supply chains, i.e.

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3 first-tier suppliers need to first fulfil focal companies' sustainability requirements as an agent
4 and then implement the requirements in their suppliers' operations as a principal.
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6 Another stream of research on multi-tier SSCM discusses the proactive sustainable
7 projects implemented in multi-tier supply chains (Plambeck and Dened, 2011; Lee *et al.*,
8 2014; Plambeck *et al.*, 2012; Grimm *et al.*, 2014; Ablander *et al.*, 2016). Among these,
9 Plambeck and colleagues conduct a series of studies on Walmart, which implemented
10 proactive sustainable initiatives together with third parties (e.g., NGOs) and cover its multiple
11 levels of supply chain members. Plambeck *et al.* (2012) emphasize that it is important for
12 focal companies to learn from suppliers and facilitate learning among suppliers.
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17 Two papers on multi-tier supply chains are highlighted in this study. Having identified
18 the approaches which focal companies can use to interact with Tier 1 and Tier 2 suppliers,
19 Mena *et al.* (2013) propose three types of triadic supply chain structures, i.e. open,
20 transitional and closed triad. An open triad is a traditional supply chain through which
21 information and product flow is linear and there is no direct connection between a buyer and
22 Tier 2 suppliers. On the other hand, a closed triad represents a situation where the buyer has
23 an established and direct connection with Tier 2 suppliers. Finally a transitional triad is a state
24 between these two in which a buyer reaches out to Tier 2 suppliers (such as through
25 providing training and direct sourcing) to build connections in order to become a closed triad.
26 Mena *et al.* (2013) suggest that the three forms of triad are linked with different levels of
27 management resources (e.g., investments of staff time and capital), in which an open triad
28 requires fewer management resource and a closed triad requires much more resources.
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37 The second study by Tachizawa and Wong (2014) further develops Mena *et al.*'s (2013)
38 to a SSCM context linking nicely SSCM and multi-tier supply chain by reviewing 39 papers
39 with a focus on lower-tier suppliers. They propose four governance mechanisms of "direct",
40 "indirect (through Tier 1 supplier)", "work with third party" (e.g., NGOs) and "don't bother"
41 approaches for focal companies to interact with lower-tier suppliers on SSCM, which may
42 complement each other and a firm may simultaneously rely on more than one approach for a
43 specific supplier. Tachizawa and Wong (2014) also study the contingency factors which
44 could affect the approaches that focal companies choose towards lower-tier suppliers. Among
45 them, the probability of the lead firm adopting the "direct" approach on lower-tier suppliers is
46 positively affected by its knowledge resources; the probability of the lead firm adopting the
47 "work with third party", "indirect" and "don't bother" approaches on lower-tier suppliers are
48 negatively affected by its knowledge resources. Here the knowledge resources means whether
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the focal company have the relevant sustainability related knowledge and technical expertise (Tachizawa and Wong, 2014).

Almost all of the above studies adopt a static or snapshot view of supply chain sustainability without considering the temporal dimension. We argue that a process view may provide more significant insights as implementing SSCM projects could be considered a learning process for both focal companies and their supply chain partners.

2.2 Supply chain learning

Spekman *et al.* (2002) suggest that learning is a key component of supply chain competency, and that supply chain can be seen “as a vehicle for gathering knowledge and learning” (Spekman *et al.*, 2002, p. 42). Flint *et al.* (2008, p. 274) provide a definition for SCL which is adopted in this research “*Multiple supply chain partners engaged in interaction where learning occurs and is focused on supply chain issues and solutions.*”

Grounding their work in innovation literature, Bessant *et al.* (2003) divide SCL into three phases: ‘set up,’ establishing a set of procedures to promote SCL; ‘operating’, translating the procedures to routines and norms which govern the behaviour between and within firms and ‘sustaining’ dealing with management processes for the needs of continuous learning such as measurements and benchmarking. At the set up stage, triggers need to be identified to promote a learning environment either under crisis or find new opportunities. This stage is normally promoted by a core company or a third party. At the operating stage, Bessant and Tsekouras (2001) and Morris *et al.* (2006) list eight core processes including network creation, defining and maintaining the membership and decision making, and clarifying the decision making processes. At the sustaining stage, a mechanism needs to be identified to sustain the learning process or close the processes. One example of this is that Toyota set up the supplier association which is responsible for long term sustained learning (Dyer and Nobeoka, 2000). Bessant *et al.* (2003) also mention the content of learning which could be simple e.g., adoption of well-proven practices or complex e.g., reframing the entire approach taken to operations.

2.3 Resource orchestration perspective

ROP, an extension of resource-based View (RBV), is an emerging theoretical perspective, which has received attention from Operations Management (OM) scholars in the past few years (Hitt, 2011; Crook and Esper, 2014; Hitt *et al.*, 2016). Compared to RBV, which stipulates that firms could gain competitive advantages based upon valuable, rare, inimitable

and non-substitutable resources, ROP scholars suggest that “*possessing resources alone does not guarantee the development of competitive advantage*” (Sirmon *et al.*, 2011, p.1391); “*holding valuable and rare resources is a necessary but insufficient condition for achieving a competitive advantage*”; resources should also be managed effectively to generate synergistic effects (Hitt, 2011, p. 9). ROP is “*the combination of resources, capabilities, and managerial acumen that ultimately results in superior firm performance*” (Chadwick *et al.*, 2015, p.360).

Sirmon *et al.* (2007, 2011) are among the early works to develop ROP emphasising the roles of managers on structuring, bundling and leveraging firm resources. At a firm level, ROP could be elaborated in three aspects: breadth (resource orchestration across the scope of the firm, e.g., horizontal integration); depth (resource orchestration across managerial levels of the firm: top, middle and operational); and lifecycle (resource orchestration at various stages of firm maturity: start-up, growth, maturity, and decline) (Sirmon *et al.*, 2007; 2011). The breadth and depth constructs are akin to internal integration which has two dimensions/directions, i.e., horizontal (integrating with other functional departments) and vertical (integrating with different hierarchical levels within the same function) (Trent and Monczka, 2003). The difference lies in that Simon *et al.* (2007, 2011) emphasize managers’ strategic vision and planned proactivity of structuring, bundling and leveraging firm resources.

Several works apply ROP in SCM. Hitt (2011) and Hitt *et al.* (2016) suggest that ROP is a promising perspective which could be applied in OM research. Based on the level of adequacy of the resource endowments and resource orchestration, Ketchen *et al.* (2014) propose four types of product recalls in reverse supply chains: precise recall, overkill recall, cascading recall and incomplete recall. Recently, Liu *et al.* (2016) propose that ROP is particularly useful for understanding the deployment of resources and capabilities in the areas of supply chain integration (SCI) and IT competency. Researchers have also started applying this perspective in SSCM studies. Wong *et al.* (2015) adopt both stakeholder theory and ROP in their conceptual framework of green supply chain integration (GSCI). They propose that ROP is an appropriate perspective to examine the integration of environmental management in supply chains (Wong *et al.*, 2015).

This research is focusing on the focal companies’ proactive SSCM initiatives, which cover multi-tier suppliers, focal companies potentially need to orchestrate resources both internally and externally to implement the initiatives and facilitate the SCL of sustainability, thus ROP is well positioned to explain the phenomenon and answer our research question. In adopting ROP, we are interested in how focal companies orchestrate their own and others’

knowledge and management resources to facilitate their supply chain to learn sustainability. Integrating the various literature streams, we propose that the aim and current knowledge level of SCL may motivate focal companies to orchestrate internal and external resources to implement sustainable initiatives in multi-tier supply chains, which may in turn incur change of multi-tier supply chain structure.

3. Research Methodology

Given the limited research on SCL of sustainability in a multi-tier supply chain context and our research question is a 'how' question (Yin, 2008), a retrospective longitudinal multiple case study method was adopted. We intend to explore the SCL dynamic process to answer the research question of how MNCs orchestrate resources and make their supply chain partners learn sustainability in multi-tier supply chains. By retrospective longitudinal case study, we mean that we collected data regarding the SCL process (set up, operating and sustaining) and the evolutionary changes of constructs by asking the managers to recall what had happened in the past during the SCL process. This study adopts the processes recommended in the OM literature to conduct case study research and ensure the rigour (Eisenhardt, 1989; Stuart *et al.*, 2002; Voss *et al.*, 2002; Eisenhardt and Graebner, 2007; Ketokivi and Choi, 2014).

3.1 Case Selection

Western MNCs operating in China were selected for this research because they are believed to be much more mature than Chinese companies in not only SCM, but also corporate social responsibility (Lam, 2011). Thanks to a partnership with WWF (World Wide Fund for Nature), WWFs' MNC partners were chosen as the sample pool. WWF tends to collaborate with influential industry leaders who work together with their supply chain members implementing sustainable initiatives (Trifilova *et al.*, 2013).

The unit of analysis is a sustainable initiative led by the sampled Western MNCs covering a whole supply chain. The proactive sustainable initiatives are defined as projects or practices going beyond compliance with standards or certification set by governments or any third party organization (e.g., ISO) requirements and show proactivity and importance to the focal companies concerned. Our research followed a theoretical sampling approach by selecting the best practice cases of SCL of sustainability in multi-tier supply chains. The following criteria were applied for selecting the MNCs:

- Western MNCs that have an established corporate sustainability strategy so the sustainable initiatives are strategically planned and long term;

- Western MNCs that have localized manufacturing and supply chain operations in China, making SCL possible;
- Western MNCs that have implemented proactive sustainable initiatives covering a whole supply chain of multiple tiers (at least two tiers of suppliers).

In total seven MNCs were approached for data collection initially. Cover letters explaining the research aims were sent to the executives with five agreeing to participate. Two out of the five companies were dropped after the pilot interviews with their senior executives because one company did not have a proactive multi-tier focus; the other could not provide further access to suppliers due to its internal organizational structure change. Finally, three focal companies remained including Tetra Pak, Nestlé, and IKEA. The proactive sustainable initiatives selected for each company are: creating a recycling chain (Tetra Pak), modernizing dairy farms (Nestlé) and promoting sustainable cotton initiative (IKEA). The background information of the three MNC case companies are summarized in Table 1.

Insert Table 1 Here

Finally, for the three sustainable initiatives, the unit of analysis for Tetra Pak is its recycling chain which covers four tiers including recyclers, collection companies, individual collectors and consumers; the unit of analysis for Nestlé is its modernization of dairy farms including two tiers of dairy farms and suppliers to dairy farm. For IKEA, it is the sustainable cotton project covering six tiers of suppliers including cutting and stitching, dyeing, weaving, spinning, ginning and cotton farming (from Tier 1 to Tier 6). Hence, two forward supply chains and one reverse chain were selected, to show comprehensiveness in case selection.

3.2 Data Collection

Semi-structured interviews were conducted as the primary data source. Eisenhardt and Graebner (2007) suggest that interviews are a highly efficient way to gather rich, empirical data especially when the phenomenon of interest is highly episodic and infrequent, which are tacitly stored in interviewees' minds. To reduce respondents' bias, multiple interviewees including focal companies' senior executives and managers, managers of different tiers of suppliers (Tier 1, middle tier and extreme upstream), government agencies, NGOs or other third parties with knowledge of the sustainable initiatives were interviewed providing

multiple perspectives. One of the strengths of this study is that we were given full access to the sustainable initiatives including personnel from focal companies, their multi-tier suppliers and key stakeholders.

In total, 43 interviews were conducted with a focus on the three sustainable initiatives. A list of the 43 selected interviews (Tetra Pak: 8; Nestlé: 13; IKEA: 22) is shown in Appendix 1. An interview protocol was customized for each company and as a guidance for these interviews (see Appendix 2). There were fewer number of interviews for Tetra Pak because the recyclers tend to have similar practices on collectors and which their learning efforts are simple.

Three rounds of data collection were carried out between late 2014 and early 2016: the first round between September and October 2014 with a focus on the senior executives of each focal company on the overall sustainability strategy to identify sustainable initiatives covering multi-tier suppliers; the second and major round of data collection between April and May 2015 when the interview protocol and questions were used to explore the various constructs (e.g., SCL content) and issues in the whole implementation process of the three sustainable initiatives (Appendix 2). Majority of the data were collected in this round. Finally the third round of data collection (additional interviews) was carried out between November 2016 and January 2017 to obtain the missing data e.g., interviews with suppliers not being captured in the second round. Further questions were asked by telephone calls and emails after the three waves.

Of the interviews with multi-tier suppliers, the suppliers were purposely selected to represent their different types/tiers and cover the whole upstream supply chain or whole recycling chain. For instance, Tetra Pak's recyclers were selected based on different recycling technologies (e.g., Polyol's separation technology, plastic-wood technology). The field visits to Nestlé's dairy farms were selected based on Nestlé's internal grading (e.g., A, B, C, D to grade dairy farm's levels). Finally, IKEA's suppliers were selected based on the level of vertical integration: from fully vertically integrated suppliers to multi-tier supply chain with suppliers covering all the stages of cotton-textile supply chain.

The majority of interviews (41) were conducted in Chinese Mandarin, with two in English. All the interviews were digitally recorded except for one in which interviewee did not agree to be recorded. Detailed notes were taken for this one. 37 of the interviews were conducted face to face in 11 cities across China, and six interviews were conducted via telephone either due to distance or interviewees' time schedule conflict. Field notes were taken during and after the interviews to record immediate reflections of the field researchers.

The average length of the interviews with focal companies lasted for around 60 minutes, while the average length of interviews with suppliers lasted for around 50 minutes. Fieldwork was called off when a theoretical saturation was reached (Eisenhardt, 1989), i.e. further interviews did not provide new information to the understanding of the research question.

All the recorded interviews were transcribed into Chinese/English with more than 440,000 characters/words in total. There are in total more than 600 pages of transcripts and field notes. One of the co-authors personally transcribed 32 interviews and 10 interviews were transcribed into Chinese by a professional company. The company followed a highly ethical procedure by assigning the transcription of an interview to two or more people to transcribe and finally an administrator integrated the parts together and sent it to us.

Besides these formal interviews, a number of informal interviews/conversations were conducted along with the factory/plant tours and training sessions. Factory visits were made to Tetra Pak's Shanghai plant and three recyclers, ten Nestlé dairy farms and nine IKEA suppliers with two Tier 1 suppliers, one cotton farm and six other lower-tier suppliers. One of the co-authors has also attended a three-day training sessions provided by Nestlé to observe dairy farmers' learning activities.

The data were saved in a database together with any digital information provided by the interviewees. Photos were taken wherever permitted and kept as reminders of the field experience and to provide a different data source. Archival data were also extensively collected including company websites, news coverage, public corporate social responsibility reports and internal company documents. These multiple sources of data were applied as a way for triangulation (Eisenhardt, 1989).

3.3 Coding and Data Analysis

After data collection, data were coded and analysed. Within-case analysis was first conducted and followed by the cross-case analysis. The aim of within-case analysis is to identify the constructs and the relationship between constructs. Three case summaries based on the three sustainability initiatives were developed at this stage. Coding was done via an iterative process with both the interview transcripts and secondary data by two researchers independently and notes were compared (both are bilingual and fluent in both English and Chinese). Agreements were reached for all the constructs and relationships after many rounds of discussions. Cross-case analysis is aimed at identifying the patterns in different settings and seeks to increase the external validity of the findings. Comparison of the three focal companies' knowledge resources and suppliers' learning complexly, focal companies'

knowledge resource orchestration activities were further coded to identify patterns. The cross case results were iteratively discussed with two of the co-authors who were not involved in the data collection and played a “resident devil’s advocate” role to bring a more objective view (Sutton and Callahan, 1987; Jia *et al.*, 2014).

Pratt (2009) suggests that a qualitative research may build new theory or elaborate existing theory. We position our study in between these two extremes, i.e., we have a prior framework, which integrates SCL and supplier governance in multi-tier supply chains via the ROP. The whole process is iterative coming back and forth between data and literature.

Attention was paid to the constructs identified in the literature of multi-tier SSCM and SCL. For instance, in multi-tier SSCM, the supplier governance mechanisms were coded based on Tachizawa and Wong’s (2014) four types of direct, indirect, work with third party and don’t bother; multi-tier supply chain structure was coded based on Mena *et al.*’s (2013) open, transitional and closed triad. SCL was coded based on the sustainable initiative implementing stages following Bessant *et al.*’s (2003) three stage of SCL; the learning content in terms of focal companies’ knowledge and management resources (high, medium or low) and the level of suppliers’ learning activity complexity (high, medium or low). While coding, the three stages of SCL were first identified and followed by the pattern recognition of the changes of the key constructs of knowledge resources, supplier governance mechanisms and supply chain structure over the duration of the SCL process.

Various tools were applied to analyse both the semi-structured interview data and the secondary data (Miles *et al.*, 2013). Microsoft Excel was applied for data reduction and coding. Each case was coded in an Excel spreadsheet and then the codes were further extracted and compared cross the cases in a separate Excel sheet. The reason for choosing Excel over other qualitative software, e.g., NVivo is that the latter tended to alienate the researcher from the data (Kelle, 1997) inasmuch as the researcher’s attention may focus on the tool rather than the data. Hence, many researchers only use the tool partially (Welsh, 2002). Excel is simple to use and when it is combined with manual data analysis, it gave us flexibility and closeness to manage and retrieve data.

Finally the whole research was validated according to Yin’s (2008) four tests as shown in Table 2. Construct validity was ensured by triangulating interview data with field notes and observations and being corroborated by different perspectives of supply chain actors. Our lead author is Chinese and is fluent in both English and Chinese. In order to strengthen the construct validity of the analysis results, a copy of the individual case report were sent to the senior executives of each of the three focal MNC companies for feedbacks to check accuracy

and obtain ethical approval for using the real names of the companies for publications. Internal validity was ensured by matching the pattern with the predicted one developed from literature. Using multiple cases enabled replication of the findings, providing external validity. Reliability was ensured by rigorous use of the case study protocol and developing a case study database. To reduce the possibility of respondents not recalling prior events, at least one informant for each firm involved was selected from those who had stayed for the whole duration of the implementation process of sustainable initiatives (also SCL process).

Insert Table 2 Here

4. Case description

4.1 Tetra Pak

Tetra Pak is the world's leading food packaging and processing company. Tetra Pak realizes the importance of conducting business in a sustainable manner and taking full social and environmental responsibilities. One of its sustainability initiatives is to create a recycling chain in China. In 1998, Tetra Pak China set up its Environmental Department to look into the recycling issue of used beverage cartons (UBC). After investing over 150 million RMB (21.7 million USD) in around ten years, Tetra Pak China's recycling chain took shape in 2009. It took Tetra Pak China four steps to implement the project:

- *Scanning the recycling market*, i.e., conducting field visits to analyse the UBC recycling routes and market;
- *Awareness building and partner selection*, i.e., identifying recycler candidates and persuading them to set up the recycling business;
- *Creating recycling capacity*, i.e., providing all kinds of support to recyclers including discounted factory material, facility support and providing management knowledge. Tetra Pak collaborated with a recycling technology company and a university in China to upgrade the technology and the recycling chain; collaborated and supported collection companies and introduced them to recyclers; educated individual collectors and held many market campaigns of recycling waste cartons with media and NGOs for consumer awareness building;
- *Securing the recycling capacity*, i.e., providing tailored support to each recycler and encourage them to learn from each other and look further for new technology and business development.

In the year of 2015, Tetra Pak China achieved a recycling rate of 28%, which is an achievement compared to zero 11 years ago.

4.2 Nestlé

Nestlé is the world's largest food and beverage company in terms of revenue in 2015. Nestlé emphasises a local sourcing strategy especially in big markets such as China. China's 2008 melamine crisis marked a turning point for China's dairy industry. Since then, the Chinese Government has been pushing for the consolidation of this industry and favours large scale dairy farms. In order to respond to the Government's call and support dairy farms on economic sustainability, Nestlé generally followed a four-step model to facilitate the transformation process building on the fragmented supply base of small dairy farms:

- *Supply chain mapping*, i.e., conducting comprehensive survey with the existing dairy farmers on their willingness and barriers to upgrade, looking for potential collaborators;
- *Awareness building* on both internal staff and external dairy farmers for dairy farm upgradation;
- *Capacity building*, i.e., offering price differentiation to encourage dairy farms to upgrade, financial support by liaising with a local bank to provide loans, land use support by working with local governments and facility support in terms of discounted facilities and feed. On the other hand, engaging collaborators to launch the training centre of 'Dairy Farming Institute' (DFI);
- *Capacity sustaining*, i.e., providing continuous training through DFI, which was built as an extension service platform.

Nestlé acquire expertise in modern dairy farming through collaboration with various partners (both business and academic partners) to create the platform. The majority of DFI partners belong to Tier 2 suppliers and had a weak or no relationship with Nestlé before implementing the initiative. DFI provides modern dairy farming training to Nestlé's dairy farmers and other dairy farmers (not supply to Nestlé), school students and government officials.

4.3 IKEA

IKEA is the world's largest furniture retailer. Cotton is the second most important raw material at IKEA after timber. In 2005, IKEA together with other world leading brands and organizations launched a global platform, i.e., the Better Cotton Initiative (BCI), which aimed

to make cotton production better for the people who produce it, better for the environment it grows in, and better for the sector's future (BCI, 2017). In 2011, IKEA started implementing sustainable cotton initiative in China. A dedicated sustainable cotton team was set up for this purpose. The target of the project is to promote sustainable cotton practices at the cotton field level and IKEA's final products made from cotton should be 100% sourced from sustainable cotton sources, which was achieved globally by the end of its financial year of 2015. The project also followed four steps:

- *Supply chain mapping*, i.e., mapping the cotton-textile supply chain to the cotton farm level;
- *Awareness building*, i.e., holding trainings and workshops with Tier 1 (cutting and stitching) suppliers and key Tier 2 dyeing/weaving suppliers;
- *Capacity building*, i.e., besides providing access to foreign BCI suppliers, getting direct contact with Tier 5 ginneries and Tier 6 cotton farmers in China with an aim of implementing the sustainable cotton initiatives to these suppliers and engaging BCI in the cotton farming training;
- *Securing the supply chain*, i.e., as a promise to BCI, continuously developing Chinese cotton farms.

At the end of financial year of 2014, IKEA China achieved sourcing 100% from sustainable cotton sources, one year ahead of its group target.

5. Cross case analysis

5.1 Supply chain learning through resource orchestration

We have identified two aspects of SCL content: focal companies' knowledge resources and suppliers learning complexity echoing Bessant *et al.* (2013). Table 3 highlights the knowledge resources of focal companies, their corresponding knowledge resource orchestration activities and supplier learning complexity of the three cases. We found that focal companies may have different levels of knowledge resources in terms of supply chain knowledge and sustainable technology knowledge. Tetra Pak had a high level of knowledge resource because it had the recycling expertise and similar recycling projects implemented in other countries (supply chain knowledge). IKEA had a medium level knowledge resource in that it had the cotton-textile supply chain knowledge but did not have expertise in cotton farming. Finally, Nestlé had a low level of knowledge resource as it had neither the

experience of providing modern dairy farming training to dairy farms nor the dairy chain management knowledge in China initially.

However, it is interesting to find that all the three focal companies proactively orchestrated both internal and external knowledge resources in order to implement the sustainable initiatives. Internally, all the three focal companies set up new boundary spanning departments, i.e., environment department for Tetra Pak, DFI department for Nestlé and sustainable cotton team for IKEA to coordinate the sustainable initiatives respectively.

The three companies also orchestrated resources in breadth externally by collaborating with third party knowledge providers and knowledge brokers. The knowledge providers are the organizations which bring in the needed knowledge resource to the supply chain network (Capó-Vicedo *et al.*, 2011; Tachizawa and Wong, 2014), whereas the knowledge brokers are organizations which disseminate the knowledge to wider supply chain network (Hult *et al.*, 2000; Knoppen *et al.*, 2015). They actively searched for and collaborated with various knowledge providers to fill the knowledge gap and implemented the initiatives. Tetra Pak supported the development of recycling technologies by a recycler and an university in Shandong province (knowledge providers) to enhance the value offered by the recycling chain and further motivated recyclers to participate in the recycling business; Nestlé collaborated and relied on Tier 2 suppliers (e.g., dairy farming equipments and service providers) and academic institutes as knowledge providers to design and provide modern dairy farming training; and finally IKEA relied on BCI (knowledge provider) to provide and organize trainings to cotton farmers.

The three case companies also collaborated with various knowledge brokers to disseminate the knowledge: Tetra Pak collaborated with NGOs and media to educate consumers for environmental protection and raise awareness that UBCs can be recycled; Nestlé collaborated with media to recruit potential trainees for DFI; and finally IKEA collaborated with BCI to disseminate the sustainable cotton knowledge and the industry trend to the whole supply chains through BCI's annual conference and a number of training sessions per year. Here, BCI serves as both a knowledge provider and a knowledge broker.

The three case companies also orchestrated resources in depth along their supply chains by working directly or indirectly with the whole supply chain including middle tier and extreme upstream suppliers. Tetra Pak created the recycling chain with all the four tiers of suppliers: educating the consumers as raw material providers (Tier 4), working with individual collectors (Tier 3), collection companies (Tier 2) and developing recyclers (Tier 1) from the very beginning; Nestlé had been working with dairy farmers (Tier 1) by

collaborating with DFI partners (Tier 2) and providing training to dairy farmers through DFI; and IKEA directly influenced and worked with the raw material suppliers (Tier 5 ginners and Tier 6 cotton farms), directly provided training to Tier 1 and key Tier 2 suppliers, and influenced the middle tier suppliers through Tier 1 and 2 suppliers and BCI, who provided training to all tiers of suppliers.

Table 3 summarizes the learning content complexity (i.e., low, medium and high knowledge complexity) of the three MNCs' supply chains. It can be seen that the learning content and their complexity is different between the first-tier, middle tier and extreme upstream suppliers.

Insert Table 3 here

5.2 Multi-tier supply chain governance mechanisms

Tachizawa and Wong (2014) propose conceptually that in a multi-tier supply chain, focal companies can apply four approaches on their lower-tier suppliers: "Direct", "Indirect", "Work with third parties" and "Don't bother". This research identifies that the case companies applied all the approaches in a combined and dynamic manner (Table 4).

Tetra Pak approached the collection companies directly (a way to help recyclers quickly build up recycling capacity) and indirectly with individual collectors through collection companies at the early stages. At the 'capacity sustaining' stage, Tetra Pak mainly approached the collection companies both directly and indirectly through recyclers and a 'don't bother' approach with individual collectors. However, Tetra Pak have always approached consumers through a direct approach given that Tetra Pak have a strong expertise in public relations promoting the environmental protection practices (e.g., UBC can be recycled) to the public.

Nestlé approached the DFI partners directly and relied on DFI partners' knowledge resources to provide training to dairy farmers either within its existing supply chain network of its milk districts or externally to the wider dairy industry.

IKEA approached the middle tier suppliers (Tier 2-4) through both a direct and an indirect approach at early stages. It provided training directly to some Tier 2 suppliers along with Tier 1 suppliers while also indirectly approaching some Tier 2 suppliers via Tier 1 suppliers who passed on information and requirements to tier 2 suppliers. For Tier 3 and 4 suppliers, IKEA mainly adopted an indirect approach and influenced them through the Tier 1 or Tier 2 suppliers. At the 'capacity sustaining' stage, IKEA mainly applied an indirect and

work with third party (i.e., BCI) approach on these middle tier suppliers. For Tier 5 and 6 suppliers, IKEA adopted both direct and work with third party approaches. As a commitment to BCI, IKEA continuously developed cotton farms who are willing to participate in sustainable cotton initiatives and applied a direct approach on Tier 5 or Tier 6 suppliers. Table 4 summarizes governance mechanisms adopted by the case companies on their lower-tier suppliers (except for Tier 1).

Insert Table 4 here

5.3 Multi-tier supply chain structure

According to Mena *et al.* (2013), there are three types of triadic supply chain structure: open triad, transitional triad and closed triad. Figures 1 to 3 present the evolving statuses along the three learning stages of the three types of supply chain structures but the supply chains of this study contain more tiers than Mena’s (3-tier). Building on Bessant *et al.* (2003), we refer the first two stages of supply chain mapping and awareness building detailed in the case description section as the ‘set up’ learning stage; the capacity building stage as the operating stage; and the final capacity sustaining stage as the sustaining stage. We illustrate the overall supply chain structures and the triadic structures of focal company, Tier 1 suppliers and Tier 2 suppliers in Figures 1-3.

We identified all the three types of triadic structure proposed by Mena *et al.* (2013) based on our mapping of the three MNCs’ supply chains and the governance mechanisms adopted. At operating stage, a new type of triadic supply chain structure emerged from the data collected in addition to the three types and we label it ‘**closed plus triad**’ structure describing a situation where a focal company initiated the relationship with new lower-tier suppliers who did not have any transactions with the focal company before introducing them to Tier 1 suppliers in order to close the loop. It is called this because there was no existing relationship between Tier 1 and the lower-tier suppliers introduced by focal companies previously and the focal companies need to make extra efforts to identify and develop the new lower-tier suppliers before introducing them to their existing Tier 1 suppliers. Both Tetra Pak and Nestlé directly identified the Tier 2 suppliers as new suppliers and introduced them to Tier 1 suppliers.

Insert Figures 1-3 Here

From the set up stage to operating stage in Figures 1 to 3, it is shown that Tetra Pak moved from a single firm to an overall closed recycling chain. The relationship between Tetra Pak, recyclers and collection companies represents a closed plus triad, in which Tetra Pak identified the collection companies (new Tier 2 supplier) and introduced them to recyclers (Tier 1). Nestlé also identified DFI partners (Tier 2) and introduced them to dairy farmers (Tier 1) to create a closed plus triad. IKEA moved from an open supply chain to an overall closed supply chain but it changed from open to a transitional triad with Tier 1 and 2 suppliers.

From the operating to sustaining stage, Figures 1 to 3 show that Tetra Pak's recycling chain is still a closed supply chain, however the closed plus triad with recyclers and collection companies changed to a transitional triad. Nestlé's closed plus triad changed to a closed triad, in which Tier 2 DFI partners gradually built a close relationship with Tier 1 dairy farms. IKEA's supply chain is still an overall closed supply chain while the triadic structure (with Tier 1, 2 suppliers) changed from a transitional to an open triad.

6. Discussion

This section discusses and clarifies the findings of cross case analysis by comparing the findings with the literature. In order to answer the research question, a refined framework is proposed in Figure 4 adopting ROP and three sets of propositions are developed. We discussed SCL content in terms of focal company knowledge resources and supplier learning complexity; and resource orchestration in breadth and in depth through governance mechanisms; multi-tier supply chain structure; and SCL stages of set up, operating and sustaining, which is aligned with resource orchestration along the project lifecycle. We further classify the supplier governance mechanism of working with third party together with internal breadth of setting up new functional departments as resource orchestration in breadth. Direct, indirect and don't bother governance mechanisms are under resource orchestration in depth as they are applied to the multi-tier suppliers. We propose that resource orchestration in breadth and depth play a mediation role to the relationship between SCL content and multi-tier SSCM structure and that SCL content, resource orchestration in breadth and depth and multi-tier SSCM structure change along the SCL stages. Detailed discussion is provided below.

Insert Figure 4 Here

6.1 Relationship between SCL and resource orchestration

We found that focal companies tended to use different governance mechanisms on their suppliers. Tachizawa and Wong (2014) propose that the contingency factors including knowledge resources determine the approach chosen by the focal companies to implement sustainable initiative. According to their propositions 3-6, the probability of a focal company adopting the “Direct” approach is positively affected by knowledge resources; the probability of adopting the “work with third party”, “Indirect” and “Don’t bother” approaches are negatively affected by knowledge resources (Tachizawa and Wong, 2014, p. 658-659).

Tacit knowledge resources could be considered as the most valuable resources of a firm and key implementation of sustainable initiatives, which is difficult to imitate and the knowledge at the supply chain level could enable the supply chain members to gain and sustain competitive advantages (Wowak *et al.*, 2013; Tachizawa and Wong, 2014); whilst management resources (i.e., investment of staff time and capital) are also critical according to Mena *et al.* (2013). Both types of resources can therefore be considered valuable, rare, inimitable and non-substitutable (VIRN) (e.g., Barney, 1991; Rungtusanatham *et al.*, 2003).

This research supports the salience of knowledge resources as an important dimension of SCL, however our findings do not support Tachizawa and Wong’s (2014) proposition that “work with third party” is negatively affected by focal companies’ knowledge resource. The three focal companies had different levels of knowledge resources, however all of them worked with third parties such as knowledge providers and knowledge brokers proactively. This contradictory result may be due to the proactive nature of the three initiatives selected.

Focal companies tend to work with third parties of knowledge providers (e.g., external technology company in Tetra Pak’s recycling chain; DFI partners in Nestlé’s dairy supply chain; and BCI in IKEA’s cotton-textile supply chain) to bring in knowledge for suppliers facing high learning complexity and knowledge brokers (e.g., Tetra Pak worked with media, NGOs, to educate consumers; Nestlé worked with media to recruit DFI trainees; and IKEA worked with BCI on middle tier suppliers) to disseminate the knowledge to suppliers with low learning complexity.

Our findings also do not support Tachizawa and Wong’s (2014) proposition that a “direct” approach may be positively affected by knowledge resources. This is refuted by the fact that IKEA did not have sufficient knowledge resource to train cotton farmers, however it reached out to the cotton farms to build the direct collaborative relationship. Nestlé did not have the modern dairy training knowledge, however it collaborated with the DFI partners

directly to provide training to the dairy farms. It seems that proactive companies tended to approach their upstream suppliers directly regardless of their knowledge resources.

The findings also do not support Tachizawa and Wong's (2014) proposition that there is a negative relationship between knowledge resources and "Indirect" and "Don't bother". For instance, Tetra Pak had more knowledge resources in terms of recycling network than a collection company and collectors but still applied the "Indirect" and "Don't bother" mechanisms because recyclers gained the capability and could work well with collection companies and collectors and the learning content for these middle suppliers is low. Based on the discussion and cross-case findings at section 5.1, we propose our first set of propositions below:

Proposition 1: *Focal companies with different levels of knowledge resources tend to orchestrate internal and external resources by applying different governance mechanisms on lower-tier suppliers facing different levels of learning complexity to make their supply chains learn and implement sustainability in their multi-tier supply chains.*

Proposition 1a: *Focal companies tend to work with third party knowledge providers to obtain needed knowledge resources to support suppliers with high learning complexity and collaborate with external knowledge brokers to disseminate knowledge to suppliers with low learning complexity.*

Proposition 1b: *Focal companies with insufficient knowledge resources tend to apply a "direct" approach on lower-tier suppliers especially when the suppliers' complexity of learning content is high.*

Proposition 1c: *Focal companies with Sufficient knowledge resources tend to apply an "indirect" or "Don't bother" approach on lower-tier suppliers especially when the suppliers' complexity of learning content is low.*

Proposition 1a is related to resource orchestration in breadth and propositions 1b and 1c related to resource orchestration in depth (Figure 4).

6.2 Resource orchestration and supply chain structure

Figures 1-3 suggest that proactive focal companies may have the knowledge resources (e.g., Tetra Pak) or lack of a certain knowledge resource (e.g., Nestlé and IKEA). In order to implement the sustainability initiatives in a multi-tier supply chain, these companies tended to work with external partners no matter whether they have knowledge resources or not.

However, before orchestrating external knowledge resources, all the three focal companies tended to orchestrate their internal resources to enhance its knowledge base first by setting up new boundary spanning functional departments to work with suppliers and potential external partners. These new departments coordinated each focal company's sustainable initiatives respectively. This supports similar arguments by Arlbjørn *et al.* (2007) and Hart (1995) that focal companies tend to prioritize orchestrating internal resources before orchestrating external resources.

The focal companies have not worked with the external knowledge suppliers before implementing sustainable initiatives and tended to orchestrate external resources in order to gain the needed knowledge resources or disseminate the knowledge to implement sustainability initiatives. They changed the supply chain structure by involving new members in the chain. Thus we propose that:

Proposition 2a: *Focal companies implementing sustainable initiatives tend to orchestrate resources by expanding the breadth of resource orchestration to obtain needed knowledge resource (e.g., NGO, universities) or disseminate the knowledge resources (e.g., NGO, media), which leads to a change of the supply chain structure.*

Tate *et al.* (2013, p. 271) propose that “For firms to enjoy the maximum benefits of diffusion of environmental business practice (EBP) into their supplier network, they need to maintain some weak external ties to bring in external innovation and new ideas”. This proposition holds true in this study in a sense that Tetra Pak collaborated with recycling technology companies bringing new recycling technologies into the recycling chain, with whom Tetra Pak had a weak tie initially.

However proactive focal companies could also engage with external parties in the existing supply chains and turn the weak ties (loose connections commonly external to the main network) to strong ties (more intense interactions in the relationships) to foster more collaborations (Hitt, 2011).

Mena *et al.* (2013, p.70) propose that “A buyer who wants to influence key product characteristics need to connect directly with its suppliers’ supplier who works with undifferentiated resources (proposition 2).” The Nestlé case provides support for this argument. We found that Nestlé has been proactive to work directly with the raw material suppliers (dairy farmers) from the beginning. While implementing sustainability initiative, it worked directly with raw material suppliers’ suppliers (i.e., DFI partners), who served as

knowledge providers and previously only had a weak link or no relationship with Nestlé. Based on above arguments and findings at section 5.3, we propose that:

Proposition 2b: *Proactive focal companies tend to orchestrate external resources by expanding the depth of orchestrating supply chain members and working directly with lower-tier suppliers to implement the proactive sustainable initiatives.*

Proposition 2c: *The closed plus triad structure (working with and then introducing lower-tier suppliers to upper-tier supplier) is created by proactive focal companies as a result of resource orchestration in depth to facilitate Tier 1 suppliers to learn when the complexity of learning content is high.*

Proposition 2d: *The external knowledge suppliers could even join focal companies' supply chain and become a supply chain member, changing their relationship with focal companies from a weak to a strong tie.*

6.3 Resource orchestration, supply chain learning and supply chain structure change along the project lifecycle

Based on Table 4 and Figures 1-3, this section discusses how SCL content, resource orchestration and multi-tier supply chain structure change along the project lifecycle, i.e., the SCL stages.

6.3.1 Changes to SCL content

Along with the learning process, the cross case analysis suggest that the focal companies' knowledge resources tended to accumulate over the learning process and peaked at the sustaining stage. On the other hand, the learning complexity for suppliers tend to be reduced since they gradually acquired the needed knowledge resources. For instance, IKEA's Tier 1 suppliers found it difficult to implement the sustainable cotton project in the set up stage because they didn't have much knowledge on the sustainable raw materials. These Tier 1 suppliers gradually gained the knowledge and experience at the operating stage and were expected to take responsibility for the purchase of sustainable cotton at the sustaining stage.

Thus, this research proposes that:

Proposition 3a: *Focal companies' knowledge resources tend to accumulate over time and peak at the sustaining stage while learning complexity of multi-tier suppliers reduces over time due to the learning efforts put in by the suppliers and support provided by focal companies.*

6.3.2 Changes to resource orchestration and multi-tier SSCM structure

Governance mechanisms (direct, indirect, work with third party and don't bother) are ways in which a MNC increases the depth and breadth of resource orchestration. Focal companies had applied a direct approach consistently on extreme upstream suppliers, who are either raw material suppliers (i.e., consumers in Tetra Pak, and cotton farmers in IKEA) or knowledge suppliers (i.e., DFI partners in Nestlé). The focal companies may also work with third parties to exert a greater influence over extreme upstream suppliers (i.e., IKEA's work with BCI focusing on ginner and cotton farmers). The overall supply chain structure tends to remain closed. We therefore propose that:

Proposition 3b: *Proactive focal companies tend to orchestrate resources in breadth and depth consistently throughout the project lifecycle by applying an approach of “direct” and/or “work with third party” on extreme upstream suppliers, to create an overall closed supply chain structure.*

Focal companies tend to apply various governance mechanisms on Tier 2 suppliers. Along with the changing governance mechanisms, focal companies' triadic structure tends to change to one involving more management resources from set up to operating stage and fewer management resources from operating to sustaining stage. For instance, Tetra Pak collaborated with the collection companies (Tier 2) to facilitate the development of recyclers (changing from a single firm to a closed plus triad), and then relied on recyclers to manage their own recycling network at the sustaining stage (a closed plus triad changed to transitional triad), thus management resources required were less at the sustaining stage in the relationship. In the Nestlé case, the triadic structure shifted from a closed plus triad to a closed triad because DFI partners shared Nestlé's responsibility to upgrade dairy farms. In the IKEA case, the triadic structure changed from a transitional triad to an open triad. This means that IKEA tended to delegate sourcing of sustainable cotton to Tier 1 suppliers completely. Based on the above, we propose that:

Proposition 3c: *The overall trend for supply chain structure is to input more management resources while the project evolves from set up to operating stage and fewer management resources while it evolves from operating towards the sustaining stage in the project lifecycle.*

7. Conclusion

By applying a multiple case study method, this research has examined three proactive sustainable initiatives covering multiple multi-tier supply chains in China. This study has gone beyond the traditional focus on implementing supplier's code of conduct by examining the proactive multi-tier SSCM practices and answering a key question of how *MNCs orchestrate resources and make their supply chain partners learn sustainability in multi-tier supply chains*. The three sets of propositions provided answer to this question. By answering this question, several important theoretical and managerial contributions could be drawn.

7.1 Theoretical contributions

First, we have understood that ROP is a valuable theoretical framework and it could be extended to a supply chain level. This research has significantly enriched and extended ROP towards a theory of SCL in multi-tier supply chains in a sustainability context. It could be concluded that SCL measures in terms of focal companies' knowledge resources and supplier's learning complexity are antecedents to research orchestration efforts in breadth and depth by the focal companies, which in turn lead to the change of supply chain structure. Therefore, focal companies could orchestrate the resources in a supply chain in three aspects: breadth (resource orchestration across the scope of the supply chain including both internal and external breadth); depth (resource orchestration across multi-tiers of the supply chain); and project lifecycle (resource orchestration at various SCL stages).

This research has found that focal companies may or may not have sufficient knowledge resources and need to orchestrate internal and external knowledge resources to implement the proactive sustainable initiatives thus making changes to supply chain structure. Our findings have countered Tachizawa and Wong's (2014) propositions on the relationships between the approaches of 'work with third party', 'direct', 'indirect' and 'don't bother' and focal companies' knowledge resources. Instead, we proposed that insufficient knowledge resources do not hinder focal companies applying a "direct" approach on lower-tier suppliers especially when the complexity of learning content is high; and sufficient knowledge resources do not hinder focal companies applying an "indirect" or "Don't bother" approaches on lower-tier suppliers especially when the complexity of learning content is low.

Second, our research has made contributions to SCL of sustainability in multi-tier supply chain literature. We might be the first significant study examining SCL in multi-tier supply chains with a multiple case study research design collecting data from the whole chain.

With this, we have provided a more nuanced measure of SCL, i.e., knowledge resources of focal firms and supplier learning complexity building on and significantly enriching Bessant *et al.* (2003). We have integrated SCL with ROP by measuring ROP project lifecycle with the three SCL learning stages, and have provided vivid cases and disclosed the ‘black box’ of how multi-tier supply chains learn sustainability. Here, related to the first point, SCL has been logically integrated into ROP as an antecedent to resource orchestration. This is a significant step forward for SCL research. Before this, there were few SCL studies (e.g., Bessant *et al.* 2003; Jia and Lamming, 2013) due to the lack of measurements and link to a grand theory (e.g., RBV). Although organisational learning is a large and mature body of literature, SCL is little known. It could be interpreted that the two measurements (focal company’s knowledge resources and suppliers’ learning complexity) are related to knowledge management (types), so the future of SCL research might be closely linked to knowledge management (e.g., Cerchione and Esposito, 2016).

Third, we have contributed to multi-tier supply chain research by enriching the supply chain structure typology. We have extended Mena *et al.*’s (2013) triadic structure into more tiers and proposed a new type of closed plus triad, which emerged from our research findings. This new type is an important addition to the existing three as it highlights the importance of proactivity of focal companies to identify new capable sub-tier suppliers, introduces them to Tier 1 suppliers and orchestrates internal and external resources to facilitate the whole supply chain to learn sustainability.

We have also discovered that focal companies might remain an overall closed supply chain structure, however, the triadic structures (focal company with Tier 1, 2 suppliers) tend to change to one requiring fewer management resources whilst evolving from operating towards the sustaining stage. It would not be sustainable for focal companies to continuously devote significant resources to govern the whole chain, however it is important for focal companies to develop the Tier 1 suppliers who could share governance responsibility echoing Wilhelm *et al.* (2016).

Fourth, the retrospective longitudinal case study research design is a strength of the research and it has allowed us to identify the sustainable initiative lifecycle and observe the changes and dynamics of SCL, resource orchestration and supply chain structure. Overall, it could be concluded that focal companies’ knowledge resources tend to accumulate over time and peak at the sustaining stage while learning complexity of multi-tier suppliers reduces over time. The focal companies tend to apply a direct and/or work with third party governance mechanism constantly on extreme upstream suppliers; while applying one or

more mechanisms of the three approaches of “Direct”, “Indirect”, or “Work with third-party” on the middle tier suppliers; the supply chain structure is associated with more management resources type evolving from set up to operating stage and a type with fewer management resources evolving from operating towards the sustaining stage.

7.2 Managerial contributions

Our research have important managerial implications. Focal companies could follow the three-stage SCL framework while implementing sustainable initiatives. At the set up stage, focal companies would conduct ‘supply chain mapping’ at the beginning to generate a thorough understanding of the supply chain network, identify potential partners and generate the criteria for selecting suppliers. Through ‘awareness building’, focal companies could persuade qualified suppliers to buy in to the SSCM vision, and align with focal companies to pursue long term sustainability goals. It is also important to ensure internal functional departments to buy in to the initiative.

Next, at the operating stage, focal companies would work on ‘capacity building’ to develop multi-tier suppliers to gain sustainability capacity. Finally, at the sustaining stages, focal companies would gradually delegate their responsibilities to Tier 1 suppliers and/or external third party partners, and encourage suppliers/partners to share or even take over the responsibility of implementing SSCM initiatives. Focal companies might not have sufficient knowledge resources and might adopt a ‘platform strategy’ (e.g., DFI) to collaborate with various partners to gain knowledge and share the workload and investment. Given the fact that focal companies put more emphasis on SSCM, suppliers’ sustainability capability would be increasingly important and firmly reflected in supplier selection criteria. Sustainability capacity would no longer be an extra requirement in procurement, but embedded as a new norm. Third party knowledge providers and knowledge brokers wishing to collaborate with MNCs would need to position themselves well in the MNCs’ supply chain and enhance two capabilities of expertise in sustainability and wider network coverage to make a wider impact on the targeting groups.

7.3 Limitations and future research directions

By adopting a multiple case study method, our research has the limitation of generalisability. Since only one sustainability initiative for each of the focal companies has been studied in this research, one should be aware that SSCM includes a range of practices and being

sustainable in one proactive sustainable initiative does not indicate that a focal company and their supply chains are truly sustainable.

Our research has also pointed out some future research directions. First, researchers might adopt an alternative method such as large sample survey to test the propositions developed in this study. Second, Gosling *et al.* (2016) suggested that the application of both transformational and transactional leadership could facilitate the implementation of proactive sustainable initiatives. Future research could examine the role of supply chain leadership in SCL of multi-tier supply chains. Third, Meqdadi *et al.* (2017) proposed that both power and trust significantly impact the supply network actors' engagement in sustainability initiatives. Both trust and power could be further examined in multi-tier SSCM.

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Tables and Figures

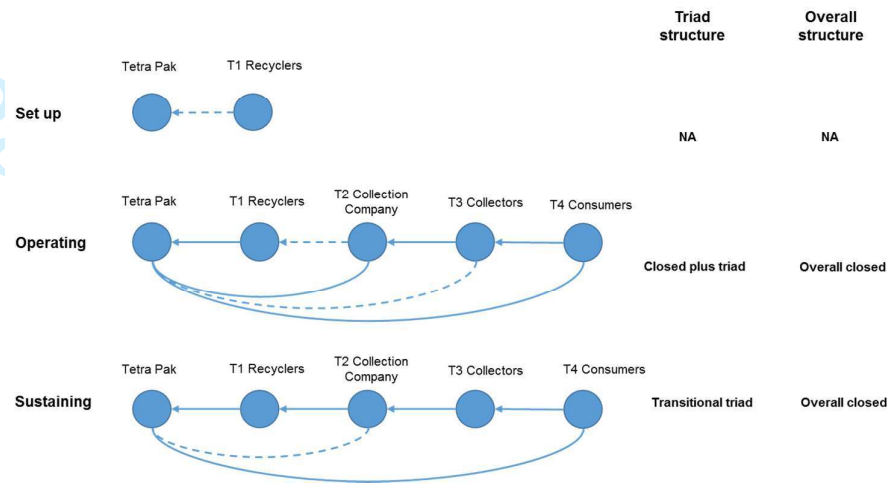


Figure 1. Tetra Pak's multi-tier supply chain structures in creating recycling chain initiative

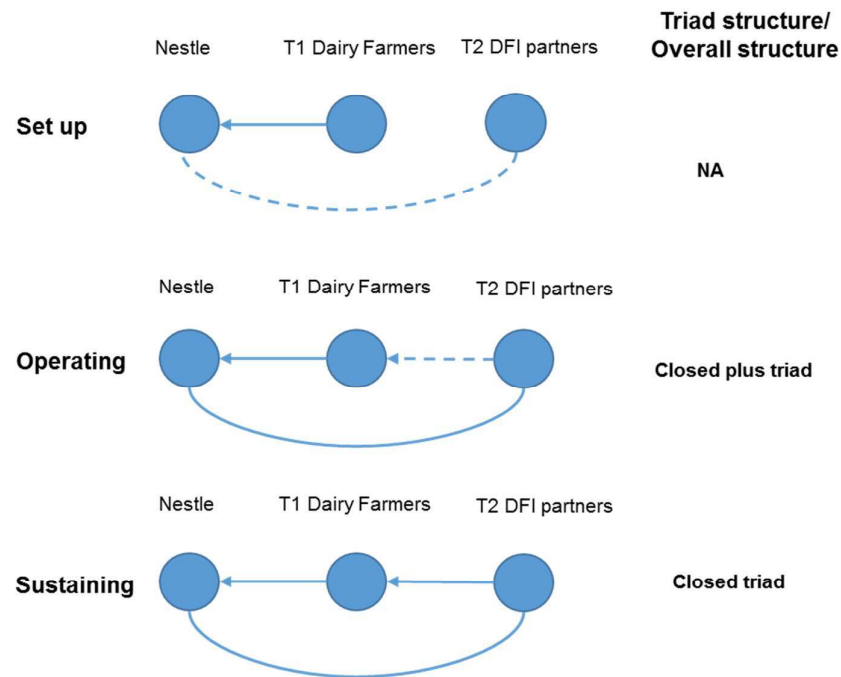


Figure 2. Nestlé's multi-tier supply chain structures in modernizing dairy farms initiative

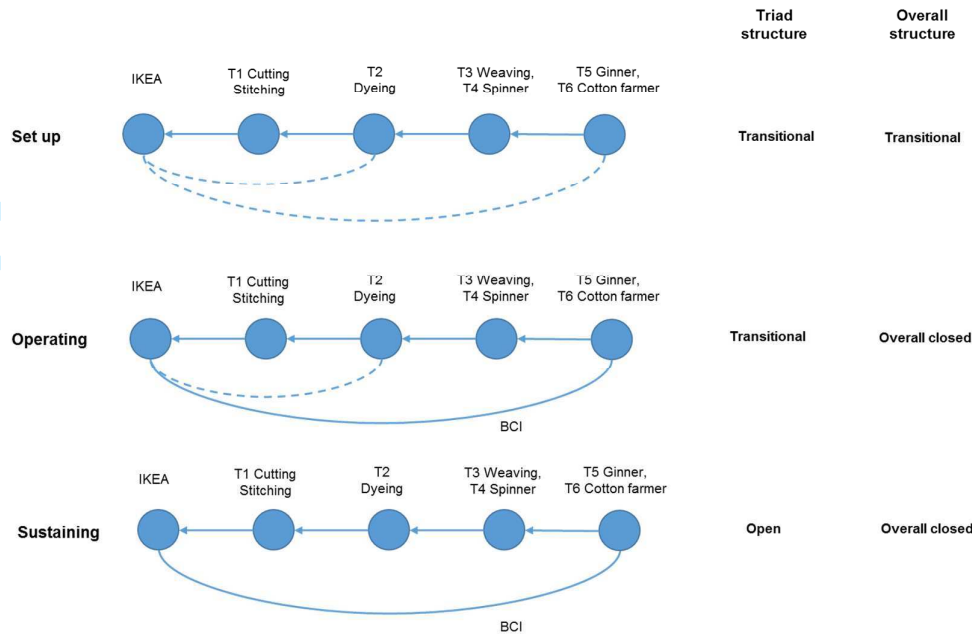


Figure 3. IKEA’s multi-tier supply chain structures in sustainable cotton initiative

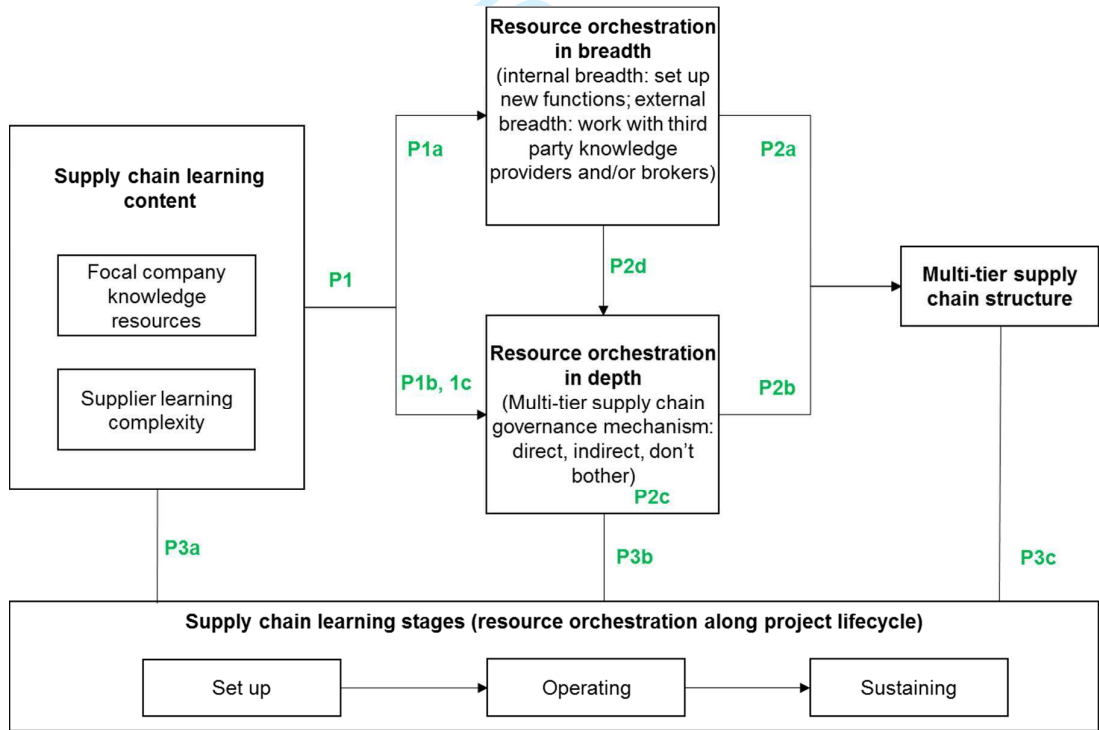


Figure 4. Proposed framework for SCL of sustainability in multi-tier supply chains

Company	Industry	Global coverage	No. of Employee	Sales Revenue	Corporate Sustainability Strategy	Proactive project
Tetra Pak	food processing and packaging	>170 countries	23,000	Euro 11.9 billion	Protect What's Good	Creating a recycling chain in China
Nestlé	food and beverage	nearly all countries around the world	335,000	CHF 88.8 billion	Creating Shared Value	Modernizing dairy farms in China
IKEA	home furnishing	operated in 43 countries	155,000	Euro 31.9 billion	People & Planet Positive	Sustainable cotton initiative

Table 1. Basic information of the case companies

(Data as in 2015; 1 Euro= 1.12 US Dollar, 1 CHF = 1.02 US Dollar)

Tests	Application in this study
Construct validity	Multiple sources of evidence including semi-structured interviews, various forms of secondary data and observations; A chain of evidence: multiple informants in focal companies, and multiple informants at multi-tier suppliers and key stakeholders; Review of findings by uninvolved senior academics; The senior managers of each focal company reviewed the draft case analysis with feedbacks.
Internal validity	Structured data coding and analysis; Development of propositions based on a chain of evidence.
External validity	Theoretical sampling approach; Thick descriptive data; Site visits to various suppliers (Tetra Pak: plant and three recyclers; Nestlé: ten dairy farms; IKEA: two Tier 1 suppliers and seven lower tier suppliers); Participate in Nestlé's training sessions.
Reliability	Use case study protocol to guide field research and analysis; Develop case study database including recordings, transcripts, field notes, sustainability reports, internal documents, academic case studies, news coverage and field photos; Iterative discussion with uninvolved senior academics.

Table 2 Reliability and validity in case research

(Adapted from Yin, 2008)

	Focal company knowledge resources	Knowledge resource orchestration	Supplier learning complexity			
Tetra Pak's recycling chain	High: Internal expertise, have the knowledge of recycling market; global recycling experience with headquarter support;	Internally: set up the environmental department to look after the recycling chain; support recycler development; provide trainings to collection company and collectors; build awareness for consumers.	T1 Recyclers High: Learned or developed recycling technologies and supply chain management, working with new suppliers (collection companies) and new customers (plastic and aluminum customers)	T2 Collection company Low: Sorting and waste classification knowledge (UBCs can be collected and recycled); worked with individual collectors and recyclers	T3 Collectors Low: Sorting and waste classification knowledge (UBCs can be collected and sold to collection company)	T4 Consumers Low: Sorting and waste classification knowledge (UBCs can be recycled)
		Externally: collaborate with recycling equipment company and university to upgrade recycling technology in order to enhance the value of the recycling chain; collaborate with NGOs, and media to educate consumers for environmental protection and raise their awareness that UBCs can be recycled.				
Nestlé's supply chain	Low: Not specialized in providing modern dairy farming trainings;	Internally: Set up DFI to coordinate with Tier 2 suppliers, which serves as a training platform for dairy farmers.	T1 Dairy farmers High: Learned modern dairy farming knowledge and the way of working with supply chain (i.e., Nestlé and Tier 2 suppliers)	T2 DFI partners High: Learned and adapted to China's market conditions to provide tailored training and products; collaborated with Nestlé and other DFI members		
		Externally: Collaborate with dairy farmers' suppliers, academics to provide world class trainings to dairy farmers, students, government officials etc.; collaborate with media to recruit potential DFI trainees.				
IKEA's supply chain	Medium: Being a founding member of BCI; not specialized in cotton farming; supply chain knowledge on its cotton-textile supply chain; other countries existing practices.	Internally: Build sustainable cotton team to look after the project; hold training events, workshops with Tier 1, key Tier 2 suppliers; develop cotton farms with BCI principles.	T1 Cutting and stitching Medium: Learned the sustainable cotton project, supply chain leadership and the way of working with supply chain to implement the project	T2-T4 Middle tier suppliers Low: Learned to comply with IKEA's requirements on sustainable cotton	T5 Ginner and T6 Cotton farmer High: Cotton farmers learned complex sustainable farming skills to implement the sustainable cotton standards on the fields	
		Externally: Rely on BCI to provide trainings to cotton farmers; rely on BCI to disseminate the sustainable cotton knowledge to the whole cotton-textile supply chain through annual conference and supplier training sessions.				

Table 3 Focal company knowledge resources, supplier learning complexity and resource orchestration activities

Focal companies	Lower Tier Suppliers	Governance mechanisms	Exemplar quotes
Tetra Pak	Collection company (Tier 2)	Direct ---> Direct/Indirect	"We used to work with collection companies, now we collaborate with some of them on garbage classification." (Senior Environmental Engineer, Tetra Pak China) "Tetra Pak has some dedicated supporting collection companies, however we have our own collection companies to work with. Because the UBCs are our raw material, we have to be active to get it from whatever sources available". (General Manager, Recycler B in Beijing)
	Collectors (Tier 3)	Indirect ---> Don't bother	"We used to provide training to individual collectors with the support of collection company when helping recyclers create their recycle volume, not anymore now". (Senior environmental engineer, Tetra Pak China)
	Consumers (Tier 4)	Direct	"Tetra Pak doesn't directly engage with recycling, however, it promotes and educates the public that UBCs can be recycled." (General Manager, Recycler B in Beijing)
Nestle	DFI partners (Tier 2)	Direct	"After our discussion, we decided to respond to the Government's call positively and do it in a way that Nestlé can add bigger value. We can also build farms, but can we do something others can't do or have not done in order to truly play a role as the industry leader? Our proposal was to build the Nestlé Dairy Farming Institute (DFI), which is open to the whole industry and can provide the much-needed training to address new changes in managing a modern farm, such as farm efficiency, environmental impact and animal welfare etc." (VP Corporate Affairs, Nestle China) "We quickly realize even as a multinational company and the biggest food and beverage company, Nestle has its very clear limitations. We scan the whole industry. If we probably need to hire a guy from company A with specialized skills, or buy R&D service from universities, we cannot do that because it is not our core business. What we do is to create a platform for the whole industry. We make it available for everybody in China." (General Manager, DFI, Nestlé China) "Nestle hope to combine the advantages of different partners, and we will then apply our strengths to participate in designing the courses. We will design a training course according to our features." (Technical Manager, A Tier 2 supplier of DFI partner of Nestlé China)

IKEA	Tier 2 Dyeing	Direct/Indirect --- > Indirect/Work with third party	<p>"IKEA provides training to us every year. They let us know the requirements and we then pass these requirements to our suppliers...we first put constraints (requirements) in the contract and make it clear that IKEA's fabric need to use IKEA recognized sustainable cotton." (Purchasing Manager, Tier 1 A supplier of IKEA China)</p> <p>"This initiative actually is like a shuffle to our supply chain, some suppliers can't collaborate then they drop out. Some of them cannot meet the target in the specified period of time agreed with IKEA, then we can't purchase from them anymore." (Purchasing Manager, Tier 1 B supplier of IKEA China)</p>
	Tier 3 Weaving		<p>"We have also invited Tier 2 suppliers for trainings, because in the end it's them who implement the sustainable initiative. Actually the training workshops are open to any suppliers who use or trade cotton". (Better Cotton Project Specialist, IKEA China)</p>
	Tier 4 Spinner		<p>"If the suppliers think BCI is a big platform and has a future, then I will persuade them to participate and attend the BCI annual conference, but whether to join the membership or not is their decision". (Better Cotton Project Specialist, IKEA China)</p> <p>"At the beginning we know nothing about BCI. We heard its name from one of our customers who also heard about BCI from their customer. It was September 2013 when there was a BCI conference, so I registered and would like to know more about better cotton initiative". (Sales Manager, Tier 4 A supplier of IKEA China)</p>
	Tier 5 Ginner	Direct and Work with third party	<p>"We directly approached the cotton farms or ginner which have a network of cotton farmers and signed contract with each cotton farm or ginner." (Sustainability Manager, IKEA China)</p> <p>"I think IKEA actually managed the two ends: one is like me as one of IKEA's direct suppliers and they need me to push the sub suppliers. But I am too far away to the final end; they (IKEA) also work with BCI to manage the cotton fields...so they managed the two ends, when the two ends are linked together, then the project will operate smoothly." (Purchasing Manager, Tier 1 B supplier of IKEA China)</p>
	Tier 6 Cotton farming		<p>"We launched the initiative before BCI entered China, so we have to develop the sustainable sources ourselves. However we are not agriculture experts, we need to rely on third parties to provide specific trainings to the cotton farmers." (Better Cotton Project Specialist, IKEA China)</p> <p>"Later on we encouraged all our sustainable cotton sources to do BCI certification. Because we are a founding member of BCI, so we will carry on to develop the potential cotton farms (after IKEA purchase 100% for sustainable sources, by authors)." (Better Cotton Project Specialist, IKEA China)</p>

Table 4 Governance mechanisms on lower tier suppliers

Tier 1 suppliers not included in the table; ---> represent the changing status during the sustainable project implementing (also SCL) process)

Appendix 1. List of interviews

No	Cases	Supply chain actors	Job title of interviewees	Date	Location
1	Tetra Pak	Focal company	VP Corporate Communication	20140922	Shanghai
2	Tetra Pak	Focal company	Senior Environmental Engineer	20141008	Shanghai
3	Tetra Pak	Recycler A	General Manager	20141011	Shanghai
4	Tetra Pak	Recycler B	General Manager	20141016	Beijing
5	Tetra Pak	Focal company	VP Corporate Communication	20150408	Shanghai
6	Tetra Pak	Recycler C	General Manager	20150412	Fuyang, Zhejiang
7	Tetra Pak	Focal company	Cluster Environmental Director	20150420	Shanghai
8	Tetra Pak	Recycler B	General Manager	20160121	Beijing
9	Nestlé	Focal company	VP Corporate Affairs	20140926	Beijing
10	Nestlé	Focal company	Corporate Affairs Manager	20140926	Beijing
11	Nestlé	Focal company	General Manager DFI	20141020	Shuangcheng, Heilongjiang
12	Nestlé	Focal company	Business Development Manager	20141021	Shuangcheng, Heilongjiang
13	Nestlé	Focal company	Fresh milk Procurement & Agriculture Service Manager	20150424	Shuangcheng, Heilongjiang
14	Nestlé	Focal company	Milk district TA supervisor A	20150424	Shuangcheng, Heilongjiang
15	Nestlé	Focal company	DFI business development manager	20150424	Shuangcheng, Heilongjiang
16	Nestlé	Focal company	Milk district TA supervisor B	20150425	Shuangcheng, Heilongjiang
17	Nestlé	Tier 1 Dairy farm	Dairy farm owners	20150425	Shuangcheng, Heilongjiang
18	Nestlé	Focal company	Milk district TA supervisor B	20150427	Shuangcheng, Heilongjiang
19	Nestlé	Tier 2 DFI partner	Project Manager	20150427	Shuangcheng, Heilongjiang
20	Nestlé	Focal company	Fresh Milk Procurement & Agriculture Service Manager	20150428	Shuangcheng, Heilongjiang
21	Nestlé	Focal company	Milk District TA Supervisor C	20150430	Shuangcheng, Heilongjiang
22	IKEA	Focal company	Sustainability Manager	20141023	Shenzhen, Guangdong
23	IKEA	Focal company	Business Development Manager A	20141106	Shanghai
24	IKEA	Focal company	Business Development Manager B	20141229	Shanghai
25	IKEA	Focal company	Deputy Sustainability Compliance Manager	20150409	Shanghai
26	IKEA	Focal company	Better Cotton Project Specialist	20150416	Shanghai
27	IKEA	BCI	Membership Officer	20150417	Shanghai
28	IKEA	Tier 5	General Manager	20150503	Songzi, Hubei
29	IKEA	Tier 1 A	Purchasing Manager	20150504	Nanjing, Jiangsu
30	IKEA	Tier 1 A	Better cotton specialist &	20150504	Shanghai

			Purchasing Manager		
31	IKEA	Focal company	Specialist Better Cotton Project	20151123	Shanghai
32	IKEA	Focal company	Business Development Manager	20151124	Shanghai
33	IKEA	Government	Secretary	20151125	Binzhou, Shandong
34	IKEA	Tier 6	Cotton cooperative director	20151126	Binzhou, Shandong
35	IKEA	Tier 3-4	Deputy General Manager	20151127	Zibo, Shangdong
36	IKEA	Tier 1-5	General Manager of Raw Material Branch	20151128	Binzhou, Shandong
37	IKEA	Tier 5-6	Agriculture Technic	20151130	Xinjiang
38	IKEA	Tier 1 B	Purchasing Manager	20151130	Jiangyin, Jiangsu
39	IKEA	Tier 2-3	Sales Manager	20151201	Jiangyin, Jiangsu
40	IKEA	Tier 2-3	CEO	20151201	Jiangyin, Jiangsu
41	IKEA	Tier 4 A	Sales Manager	20151202	Bengbu, Anhui
42	IKEA	Tier 2-3	General Manager	20151203	Shaoxing, Zhejiang
43	IKEA	Tier 4 B	General Manager	20151210	Songzi, Hubei

Note: IKEA’s cotton textile supply chains contain seven tiers of operations maximum. A supplier may cover multiple tiers of operations. Here Tier a-b means the suppliers cover the operation processes from a to b, e.g. Tier 2-3 means the suppliers have both dyeing and weaving activities. See Figures 1-3 for the seven tiers of supply chain operations.

Appendix 2. Interview protocol

1. What is your company’s SSCM strategy?
2. Which department leads SSCM projects internally? What other departments/functions have been involved and what role do they assume?
3. How do your multi-tier suppliers learn in the SSCM project? Please describe the learning process of the sustainable knowledge over time.
4. Who were involved in the implementation of the sustainable initiative and what role did they play in the implementation?
5. What specific knowledge do your multi-tier suppliers learn?
6. How does your company help multi-tier suppliers in the learning process?