Supplier absorptive capacity:

Learning via boundary objects in sustainability-oriented supplier development initiatives

Abstract

Purpose: To study the learning processes and mechanisms involved in sustainability-oriented supplier development (SSD), including how knowledge is transmitted by the buyer and how it is received, understood and internalised by the supplier.

Design/methodology/approach: An exploratory longitudinal multi-case study approach is adopted. The research context is a social SSD project focusing on occupational health and safety (OHS) management at four supplier factories. The paper draws on the constructs of absorptive capacity and boundary objects.

Findings: The development of a supplier's absorptive capacity for OHS management is triggered by the transfer of boundary objects that are created by the buyer. Findings suggest that each supplier starts explorative learning in a similar and passive way in order to accept the knowledge, but then each supplier proactively transforms and exploits the knowledge through continuous sensing, seizing, and reconfiguring loops that develop the boundary objects in a way that fits their own needs and contexts, incorporating the objects into organisational structures and routines.

Research implications: The research furthers our understanding of the development of supplier absorptive capacity for sustainability via SSD projects, including how it is triggered and sustained. The impact of ostensive and performative aspects of boundary objects on knowledge transfer is presented. Finally, insight is provided into how absorptive capacity and dynamic capabilities are linked in the context of SSD.

Practical implications: Buying firms should seek to develop boundary objects that can trigger and maintain learning momentum for sustainability at supplier organisations in addition to effectively transferring SSD-related sustainability knowledge. There is also a need to allow for sufficient flexibility in the design of the boundary objects, and to pay sufficient attention to how suppliers contextualise and embed them into their own organisations, providing support for this process where necessary. For the supplier, establishing structures and routines for OHS management can help to prepare for future audits, thereby reducing audit fatigue.

Originality/value: The paper contributes to the supply chain learning literature by exploring the development of supplier absorptive capacity for sustainability triggered by the focal buying firm. It sheds new light on the role of boundary objects for facilitating knowledge transfer and learning between supply chain members in the context of SSD projects.

Keywords: Sustainability-oriented supplier development; Absorptive capacity; Boundary objects; Supply chain learning

Paper type: Research paper

1. Introduction

Sustainability-oriented supplier development (SSD) initiatives provide a platform for collaborative knowledge transfer and learning related to sustainability (Silvestre et al., 2020; Jia et al., 2021b). Sustainability knowledge that is disseminated through such initiatives needs to be incorporated into supply chain members' business routines if the sustainability performance of the supply chain is to be enhanced (Silvestre et al., 2020). As knowledge-senders, it has been acknowledged that, by implementing SSD projects, focal firms go through a learning-by-doing process in which their capability for both learning and disseminating sustainability knowledge is strengthened (Meinlschmidt et al., 2016; Silvestre et al., 2020). There also appears to be consensus in the literature that, as knowledge-recipients, suppliers' ability to learn is an important factor that influences the effectiveness of SSD initiatives (Meinlschmidt et al., 2016; Pereira et al., 2021). Yet, it remains unclear whether and how suppliers acquire and internalise sustainability knowledge that is disseminated to them via SSD projects.

The literature suggests that the lens of absorptive capacity has the potential to further our understanding of supply chain learning by unpacking the knowledge flows between buyers and suppliers (Sáenz et al., 2014). Absorptive capacity refers to a firm's ability to recognise the value of external knowledge and leverage it to create value for the firm (Lane et al., 2006; Huo et al., 2021). Absorptive capacity can be developed and maintained via existing organisational routines when it relates to a knowledge domain that the firm is already familiar with, but when it relates to new knowledge that is unrelated to current routines, a firm must dedicate effort to create absorptive capacity (Cohen and Levinthal, 1990). The latter is arguably the case for most suppliers in the context of sustainability, as it is acknowledged that suppliers tend to lack a dedicated sustainability-related team or routine (Yang et al., 2019). While the literature has consistently shown that suppliers' absorptive capacity is a key factor affecting their sustainability-relevant practices and performance, prior research has primarily limited its focus to a 'static view' of absorptive capacity (e.g. Tong et al., 2018). This approach does not take full advantage of the potential of absorptive capacity, which is a multidimensional construct that can lend itself to unpacking dynamic and evolving learning processes over time (Lane et al., 2006; Meinlschmidt et al., 2016). In particular, the development of suppliers' absorptive capacity for sustainability through learning over time during SSD initiatives, is currently underrepresented in the supply chain learning literature. Moreover, recent research (e.g. Silvestre et al., 2020; Jia et al., 2021b) has called for studies on knowledge dissemination and absorption across organisational boundaries in supply chains.

An important prerequisite for absorptive capacity to take effect is the permeability of boundaries (Roldán Bravo et al., 2020). The use of boundary objects as templates and tools to represent, transfer and develop knowledge that crosses these boundaries has been widely discussed in the organisational learning literature in the context of functional boundaries within organisations (Carlile, 2002). This includes the use of boundary objects to facilitate learning about sustainability and specific sustainability practices across functions (Benn et al., 2013; Hawkins et al., 2017). More recently, supply chain scholars have argued that the boundary object lens is also important for explaining coordination and knowledge transfer mechanisms across organisations within supply chains (Fabbe-Costes et al., 2020). In particular, Fabbe-Costes et al. (2020) examined the role played by supply chain mapping as a boundary object in achieving coordination and integration in contemporary supply chain settings. In SSD, it is common for the buyer to create templates and tools that facilitate knowledge transfer (Meinlschmidt et al., 2016). Yet the literature offers only limited insight into whether and how such templates and tools can assist suppliers in developing their capability for managing sustainability challenges.

Against this backdrop, this research examines suppliers' learning processes towards internalising knowledge gained via SSD by drawing on the constructs of absorptive capacity and boundary objects. Our research question is as follows:

> *How is supplier absorptive capacity for sustainability developed via the use of boundary objects in the context of SSD initiatives?*

A longitudinal multi-case study research design in the context of a social SSD project, focused on occupational health and safety (OHS) management, at four supplier factories has been adopted to address this research question. Social sustainability issues tend to be complex and hence require the involvement of multiple stakeholders, with problems such as OHS and labour issues negatively affecting both social conditions at the supplier and business productivity (Rodríguez et al., 2016). This context makes it especially important to investigate how suppliers can genuinely benefit from social SSD projects. In particular, we look at how suppliers develop the absorptive capacity to explore, transform, and exploit sustainability knowledge by adopting, contextualising, and enhancing two boundary objects, i.e. the concept of an OHS group and an OHS inspection checklist created by the buyer for the SSD project. The main contribution of this research is in unpacking the dynamic and evolving learning processes involved in SSD projects at the supplier side, drawing on the lens of absorptive capacity. In doing so, it also contributes to the dynamic capabilities literature, which is closely

linked to absorptive capacity. Meanwhile, a novel boundary objects perspective is offered to theorise on knowledge dissemination and learning across the boundaries of supply chain members in SSD.

The remainder of this paper is structured as follows. Section 2 details the theoretical background before Section 3 outlines the research design. The empirical findings are presented in Section 4 followed by a discussion in Section 5 that relates our findings to prior literature and develops propositions. Finally, Section 6 summarises the theoretical and practical implications, and outlines future research directions.

2. Theoretical Background

This section explains the theoretical background to this research. In Section 2.1, literature relevant to knowledge transfer and learning in supplier development (SD) and sustainability-oriented supplier development (SSD) is reviewed; and the gaps in these fields are identified. Sections 2.2 and 2.3 review the concepts of absorptive capacity and boundary objects, respectively, and shows how they are connected with knowledge transfer and learning in SSD.

2.1 (Sustainability-oriented) supplier development

Prior research has shown that the ability to continuously build usable knowledge and to deploy knowledge are critical to developing a competitive edge for the supply chain (Hult et al., 2006). Supplier development (SD) initiatives, where effective knowledge transfer between the buyer and supplier is central to value creation, have been widely used to improve supplier operational performance (e.g. cost and quality), enhancing the competitiveness of the supply base and the entire supply chain (Krause et al., 2007; Modi and Mabert, 2007; Kim et al., 2015). Early SD literature studied the practices (e.g. joint buyer-supplier teams and safeguarding procedures) and factors (e.g. shared goals and managerial mindsets) that can affect knowledge transfer and learning from the buyer's perspective (Hult et al., 2002; Krause et al., 2007; Modi and Mabert, 2007; Giannakis, 2008). For example, Giannakis (2008) showed that dedicated staff/teams appointed by the buyer facilitate knowledge transfer. Recent studies have started to look at why SD efforts are not always successful and how factors internal to the supplier affect knowledge transfer effectiveness and performance improvements (Kim et al., 2015; Powell and Coughlan, 2020). For example, one of the first studies to explore SD effectiveness from the supplier's perspective confirmed that a supplier's ability to understand and use new external knowledge positively affects their operational performance improvements (Kim et al., 2015). However, the development of learning ability and learning-based continuous improvement has received

little attention in the SD literature (Powell and Coughlan, 2020).

Within the field of sustainability-oriented supplier development (SSD), which extends the scope of SD to incorporate a sustainability element, there is a growing body of work that has focused on developing suppliers' performance or capability for managing sustainability-relevant challenges (Gimenez and Tachizawa, 2012; Jia et al., 2021a). SSD initiatives provide suppliers with the opportunity to access external knowledge, which triggers supplier learning; however, it requires supplier effort to learn and then to incorporate this learning into their daily business processes to enhance sustainability performance (Silvestre et al., 2020). The implementation of SSD projects, however, does not always guarantee benefits for the buyer; instead, they are more likely to reap rewards when suppliers are also committed to implementing internal sustainability practices (Sancha et al., 2015). However, as in the case of SD, the literature offers only limited insight into how suppliers develop an ability to learn and pursue learning-based continuous improvements (Jia et al., 2021b). Therefore, there is a need to investigate how learning is developed and sustained within supplier organisations so as to internalise sustainability knowledge. This research would further the field's understanding, from a supplier perspective, of the effectiveness of knowledge transfer and learning associated with SSD efforts. To address this gap, this study draws on the constructs of supplier absorptive capacity and boundary objects, as outlined in the next two subsections.

2.2 Supplier absorptive capacity

The literature has suggested that supplier absorptive capacity is important for enabling effective knowledge transfer, thereby achieving the goals of SD and SSD initiatives in terms of performance improvements (Kim et al., 2015; Meinlschmidt et al., 2016; Tong et al., 2018; Powell and Coughlan, 2020; Silvestre et al., 2020). In particular, absorptive capacity is often critical for innovative processes within the firm (Cohen and Levinthal, 1989; Cohen and Levinthal, 1990; Kim et al., 2015), which is relevant in the context of SSD. It involves a firm's ability to acquire and then utilise external knowledge through three sequential processes:

explorative learning, to identify and acquire valuable external knowledge;

transformative learning, to assimilate and transform valuable external knowledge; and

exploitative learning, to apply assimilated knowledge in order to create new knowledge and value for the firm

(Cohen and Levinthal, 1990; Zahra and George, 2002; Lane et al., 2006; Lichtenthaler and Lichtenthaler, 2009). Recent research into knowledge transfer regarding sustainability initiatives has either examined only a subset of these three processes, or has considered

absorptive capacity holistically without unpacking the detailed role of each process. For example, Tong et al. (2018) discussed absorptive capacity as a unified concept to understand whether suppliers implement sustainability practices, while Pereira et al. (2021) limited their discussion to the roles of explorative and exploitative learning without considering the transformative learning process. More specifically, in the context of learning stimulated by the Covid-19 pandemic, Pereira et al. (2021) found that suppliers enter the learning loop using an exploitative learning process of external knowledge and that subsequent learning loops involve both explorative and exploitative learning regarding social sustainability practices. The authors concluded that pro-active learning occurs in both the explorative and exploitative learning processes when stimulated by an unprecedented outbreak. Thus, limited attention has been given to transformative learning, although it plays a vital role in connecting explorative and exploitative learning and in integrating various sources of knowledge (Lane et al., 2006; Huo et al., 2021). In addition, there is a need to further explore the role of explorative and exploitative learning in the context of SD and SSD, given that the characteristics of this supply chain learning context could be argued to be different to the contexts studied to date in the literature; for example, it does not necessarily occur in times of crisis, as studied by authors such as Pereira et al. (2021). Thus, the present paper considers all three of the processes of absorptive capacity in an SSD context.

Given that SSD tends to involve the acquisition of new knowledge, and that absorptive capacity theorises that this should commence with the explorative learning process, there is a particular need to understand how suppliers enter the first learning loop in this context. This is especially pertinent given the conclusion of Meinlschmidt et al. (2016) and Silvestre et al. (2020) that explorative learning leads to more radical change, and that radical change is needed to address sustainability issues. Other authors have confirmed this research need in the broader supply chain learning context; for example, it has been argued that supply chain learning is faced with the challenge of gaining entry to the learning loop (Yang et al., 2019). For buying firms, effective mechanisms in this context include the implementation of SSD initiatives (Meinlschmidt et al., 2016). Meinlschmidt et al. (2016) illustrated that, through identifying deficiencies and potential risks, buying firms continuously go through learning loops to refine their absorptive capacity and routinise SSD practices. However, it is not clear whether and how suppliers can enter the learning loop to explore new knowledge, nor how they can sustain the learning loop over time.

Further, absorptive capacity and dynamic capabilities have been tightly linked in prior research (Zahra and George, 2002; Teece, 2007; Sáenz et al., 2014; Meinlschmidt et al., 2016;

Silvestre et al., 2020). Dynamic capabilities, representing a firm's ability to deal with a rapidly changing environment, are comprised of the following three capabilities:

sensing – identifying gaps and opportunities for improvements;

seizing – deciding which area to change and how; and

reconfiguring – the process of changing

(Teece, 2007; Biesenthal et al., 2019). More specifically, some research has regarded absorptive capacity as one type of dynamic capability (Sáenz et al., 2014); and some see absorptive capacity as one of the three components that constitute a firm's dynamic capabilities together with adaptive capability and innovative capability (Wang and Ahmed, 2007). Literature has also linked explorative learning and exploitative learning from absorptive capacity theory to sensing and seizing capabilities from dynamic capabilities theory (Teece, 2007). However, it is unclear how the three learning processes that constitute absorptive capacity are linked to the three capabilities of sensing, seizing, and reconfiguring. Meanwhile, research has shown that the deployment of dynamic capabilities varies across contexts (Biesenthal et al., 2019). Therefore, there is potential to consider whether the dynamic capabilities view can help to unpack how suppliers develop and use their absorptive capacity in the context of SSD.

2.3 Boundary objects

To further facilitate effective knowledge transfer and diffusion across organisational boundaries, the implementation of SD or SSD initiatives often includes the use of a set of tools, procedures, and templates (Jensen and Szulanski, 2007; Modi and Mabert, 2007; Rodríguez et al., 2016), which can be viewed as boundary objects (Hawkins et al., 2017; Fabbe-Costes et al., 2020). Thus boundary objects are any form of entity – including concepts and templates – that can cross boundaries to achieve common goals (Carlile, 2002; Jensen and Szulanski, 2007; Benn et al., 2013). For example, 'the concept of sustainability' has been used as a boundary object to promote learning and specific practices related to sustainability across knowledge and disciplinary boundaries within an organisation (Benn et al., 2013). These boundary objects can change and evolve over time during knowledge transfer processes thereby achieving a desired and/or required end state whereby solid outcomes emerge, such as success in developing new product lines (Carlile, 2002; Hawkins et al., 2017). Since knowledge transfer across the boundaries of buyers and suppliers together with learning on the supplier side are at the heart of SSD (Jia et al., 2021b), the lens of boundary objects is argued to have utility for understanding knowledge transfer and learning in SSD.

SSD research has highlighted the importance of the buyer investing in tools such as

knowledge transfer routines (e.g. Rodríguez et al., 2016) to increase the effectiveness of knowledge transfer given that boundary objects have the potential to both trigger and institutionalise learning in knowledge-receiving organisations (Jensen and Szulanski, 2007; Hawkins et al., 2017). But the extent to which boundary objects facilitate knowledge transfer depends both on:

> *the ostensive aspect* - i.e. how well they are structured and defined by the knowledge-sender; and

> *the performative aspect* - i.e. how they are used and contextualised by the knowledge-recipients

(Feldman and Pentland, 2003; Jensen and Szulanski, 2007; Biesenthal et al., 2019). More specifically, access to well-designed boundary objects can initiate knowledge transfer but it does not guarantee the use and internalisation of them within the organisations (Jensen and Szulanski, 2007). Meanwhile, the way in which boundary objects are used can differ across knowledge-recipients even if they are provided with the same set of rules and expectations in the form of boundary objects (Feldman and Pentland, 2003). This research thus examines the processes and mechanisms that explain how knowledge disseminated from the buyer is managed and developed at the supplier side by looking at the configuration and development of the boundary objects conveyed to suppliers through the SSD process.

3. Research Method

Given that research that seeks to understand how suppliers' capability for sustainability is developed remains limited, there is a need for more exploratory studies (Yin, 2018; Jia et al., 2021b). Case research is suitable for this purpose as it allows researchers to conduct a thorough examination of under-researched issues by collecting rich data from multiple sources, including interviews, observations, and documents in real-life settings (Barratt et al., 2011). Further, an in-depth case study design using longitudinal analysis is suggested as it may provide the basis for understanding evolution related to sustainability capabilities (Carter and Rogers, 2008). Therefore, considering the evolving and dynamic features of knowledge transfer and learning processes, a longitudinal multi-case study approach made up of four cases has been adopted. Table I summarises the measures taken to ensure the quality of the case study research design (Yin, 2018), as used in case study exemplars from the SSD literature (e.g. Rodríguez et al., 2016).

[Take in Table I]

3.1 Research context and case selection

We have focused on the occupational health and safety (OHS) dimension of social sustainability as it remains one of the major concerns in sustainability practice (Jia et al., 2021b). More specifically, big brands such as Nike have identified OHS issues as the top priority to address in the coming years while, at the same time, ever-stricter audits are considered insufficient for achieving this goal (Jia et al., 2021b). The context of this research is an SSD project initiated by a fast fashion brand (FF) headquartered in Europe for its suppliers based in China. The project lasted for over a year and data were collected over time at different stages of the entire lifecycle of the SSD project. The brand FF launched this project in order to improve suppliers' capability towards managing OHS issues by themselves, by helping each supplier to build a dedicated working group within its factory – a so-called OHS group – and an OHS inspection routine that is administered by the OHS group.

We identify two boundary objects in this research following the definition from the literature (e.g. Benn et al., 2013, see also Section 2.3) that refers to concepts and templates that cross organisational boundaries to transfer knowledge. In terms of the first boundary object, i.e. the concept of an OHS group, each group was designed to be comprised of staff from both the management team and shop floor across the factory. The key to this concept of an OHS group is to decentralise the responsibility from only one relevant staff member to a larger group of staff where each one is responsible for his or her own area. In addition, the group leaders were members of the middle/top management team who have the power to make decisions to support the smooth running of the OHS group. The second boundary object created by the buyer was an OHS inspection checklist, which was developed by the buyer based on past auditing experience with their suppliers. To effectively deliver these tools to suppliers, the buyer scheduled five factory visits consisting of a variety of knowledge transfer events that were delegated to an external knowledge provider (KP) – a local consultancy firm – to deliver. The knowledge transfer events included classroom training sessions, problem-based on-site and remote tutorials, assignments, and self-inspections.

The unit of analysis is the supplier. We secured access to the four suppliers, hereafter referred to as S1 to S4, that were involved in this project via initial contact with the brand FF. This approach followed replication logic to provide similar and complementary findings (Yin, 2018). We thus identified four cases, which is also suggested by prior research as an appropriate number to achieve an in-depth understanding of the phenomenon under study striking a suitable balance between complexity and volume of data (Eisenhardt, 1989; Barratt et al., 2011). In

terms of the primary data collection method, i.e. the semi-structured interviews, a purposive sampling method was used to select participants for the interviews. Key informants included all group leaders and at least two group members of the OHS group from the four suppliers (S1-S4), the consultants from the KP (KP1-KP4), and both the project manager (FF1) and project advisor (FF2) from the brand FF who were involved in the entire project.

3.2 Data collection

We developed a case study protocol that specified the aim, theoretical background, and data collection plan for the research prior to carrying out the study (Yin, 2018). The research team had regular interactions with all parties involved in the study throughout the project. Primary and secondary data were collected longitudinally over the course of the entire project, and hence the longitudinal design allowed us to collect rich data. More specifically, in addition to the two rounds of interview carried out at the start and end of the project, respectively, observations to the regular progress update meetings and all factory visit reports were reviewed as the project progressed.

In terms of the interviews, a total of 50 interviews were conducted across 26 different interviewees. There were different foci for the two rounds of interview. The first round focused on suppliers' OHS knowledge base, their learning expectations, and their plans to operationalise the concept. For example, we asked the suppliers, "how do you understand the role of the OHS group?" In the second round, at the end of the project, we asked informants about what they had learned and how they were running the OHS group. The duration of each interview varied from 10 minutes to 90 minutes; and they were conducted in Chinese, the native language of the interviewees. The interview schedule was developed in English and translated into Chinese. All the interviews were audio-recorded, transcribed and accompanied by comprehensive note-taking. Key extracts from the transcripts that had potential to be relevant to the subsequent data analysis were translated back into English. Details of the interviews, the firms accessed, and the interviewees are summarised in Table II.

[Take in Table II]

In terms of the observations and secondary data review in-between the two rounds of interviews, one of the researchers continually observed the progress of the project over the course of twelve months by attending five project update meetings, having informal chats, and reviewing six factory visit reports per supplier (see Table II). These data sources allowed us to

keep track of the actions taken by the suppliers and the KP and the phased outputs at different stages of the project. For example, factory reports specified actions taken during each factory visit, which complemented interviewees' memory and thus facilitated data triangulation. Data collection culminated in a final interview with the project manager FF1, at which point no new themes were identified and it was concluded that a satisfactory level of theoretical saturation had been reached (Eisenhardt, 1989).

3.3 Data analysis procedure

We followed an abductive reasoning approach to analyse the data by moving back and forth between deductive reasoning, where we drew on established constructs from the two theoretical lenses, and inductive reasoning, based on emerging themes from the empirical data (Ketokivi and Choi, 2014; Jia et al., 2021b). More specifically, the established constructs guided the design of the data collection and the development of higher-order codes. For example, codes such as explorative learning were generated from the literature. Meanwhile, new themes inductively identified from the empirical data provided us with additional theoretical insights, thus contributing to theory elaboration. For example, codes such as 'Visualise OHS work', inductively emerged from the data. Such an abductive approach thus allowed us to gain sufficient depth and breadth of exploration to achieve our aim of theory elaboration and development (Ketokivi and Choi, 2014). The coding process was supported by qualitative data analysis software (*N-Vivo*). Finally, Figure 1 presents the coding structure derived from the data analysis process while Table III provides example evidence for each code.

[Take in Figure 1 and Table III]

4. Findings

This section outlines the process through which the boundary objects were transferred from the buyer to the four suppliers in the SSD project to manage OHS issues. The section is divided into two subsections: within-case analysis (Section 4.1) and cross-case analysis (Section 4.2). Table III, referred to above, also presents the key characteristics of each learning process and the changes to the boundary objects during the SSD project.

4.1 Within-case analysis

The within-case analysis had three main components. First, we identified the timeline for the entire project including five key knowledge transfer events, i.e. the five factory visits for each

supplier, which were carried out over the course of a year. Second, the specific activities taken by each supplier organisation to internalise the two boundary objects, with the assistance of the KP, were identified, including when and how each supplier went through the three learning processes, i.e. explorative, transformative and exploitative learning. The final step was to identify the factors that influenced the learning processes in each case, revealing the impact of the ostensive and performative aspects of the boundary objects. The end result of the within-case analysis is a summary of the supplier absorptive capacity development processes at each supplier organisation following the timeline of the SSD project, as shown in the next paragraph and in Figure 2.

[Take in Figure 2]

The four suppliers each went through all three learning processes over the course of the project. S1 was the largest supplier factory amongst the four cases with the most relevant experience of OHS management and was the first to start proceeding with the SSD project. It began the project rather quickly by accepting the two boundary objects to explore the new knowledge; however, due to its large size, S1 faced challenges in moving to transform the knowledge. Therefore, major changes to the OHS group structure were carried out at S1 after the second factory visit. Subsequently, it entered the exploitative learning stage very quickly with efforts to try to improve the efficiency and efficacy of the established OHS inspection routine. Thus, in S1, the latter two learning processes mainly occurred in parallel. The development of absorptive capacity at S2 was mainly characterised by explorative learning. More in-depth training regarding two topics that had been covered in the OHS inspection checklist was carried out at S2 during the third and fourth factory visits, which was not prescribed by the original design of the project but was needed in this case. The process at S3 was closest to the one preferred by the FF. S3 gradually developed the ability to explore, transform and exploit the knowledge over the course of the five visits to contextualise and develop the two boundary objects. The context of S4 was unique amongst the cases studied due to a factory relocation, resulting in it needing a longer time to understand what was required and how to use the two boundary objects. At the same time as entering the transformative learning stage, it started to further exploit both the new knowledge and their previous experience related to OHS management.

4.2 Cross-case analysis
Based on an in-depth analysis of the cases, it was possible to identify both similarities and

differences between the four cases in terms of the development of absorptive capacity related to OHS management within the context of the same SSD project (also shown in Table III). The three learning processes are summarised in Sections 4.2.1 to 4.2.3 respectively, where 1) the *ostensive aspects*, i.e. the designed structure of the OHS group, the original version of the OHS inspection checklist, the expected inspection frequency; 2) the *performative aspects* of the boundary objects, i.e. the adjustments at each supplier factory to contextualise the boundary objects; and 3) and the link between the development of absorptive capacity for internalising SSD-related knowledge and the development of dynamic capabilities for managing SSD-related sustainability issues are highlighted. Section 4.2.4 finally summarises the improvements at the four supplier factories derived from the implementation of the SSD project.

4.2.1 Explorative learning

Before implementing the SSD project at each supplier, the two boundary objects – the concept of an OHS group and the OHS inspection checklist – were created by FF. Both boundary objects were identical for the four suppliers included in this project since the buyer wanted to control the outputs of this project to some degree by having exactly the same inputs. The concept of an OHS group was generated by the buyer based on the idea that "only shop floor workers really care about their health and safety condition because it is of vital interest to them, while it is only a responsibility to the management team" (FF2). Therefore, staff from both the shop floor and the management team were required. Meanwhile, by providing suppliers with the OHS inspection checklist, the suppliers were expected to obtain an overview of the scope and depth of the knowledge the buyer intended to transfer via the project.

It was found that the start of the learning process was quite similar across the four cases. Upon receiving the two boundary objects, suppliers passively accepted them and started the explorative learning process. Each consultant conducted a kick-off meeting with the middle and top management teams during the first factory visit to initiate some preparatory work for the next stage. As specified by the buyer, all of the group leaders were from the top/middle management team of the supplier organisations with a remit to make key decisions regarding investment in and operation of OHS management. This preparation work included: clarifying the goal to establish an OHS group of members collectively able to use the OHS inspection checklist; guiding the group leaders to carry out an initial inspection; and mapping the entire factory into several OHS areas of responsibility. This enabled the group leaders to start identifying and acquiring new knowledge and skills and to raise awareness regarding the management of OHS issues. Explorative learning for the group member level started when they

were selected for inclusion in the group. At least one shop floor level worker was included in the OHS group of each factory, but both the concept of an OHS group and the OHS inspection checklist were still superficial to them. For example, when asked how S3-3 understood his role as an OHS group member, he said, "I have no idea as to what I am supposed to do…maybe after the training session you mentioned just now, I can get to know more".

Classroom training was conducted at the second factory visit for S1, S2, and S3, and at the third factory visit for S4 due to factory relocation. The classroom training provided the supplier factories with an opportunity to further explore the new knowledge more deeply, making them fully prepared to begin the transformative learning process. In doing so, both group leaders and group members became clearer about what knowledge they were expected to learn and the responsibilities they were expected to take on. Therefore, the entire explorative learning process enables suppliers to passively sense that they would need to make changes to their approach to managing OHS issues following the guidance and assistance provided by the buyer during the SSD project.

4.2.2 Transformative learning

The four suppliers differed in how they moved onto the transformative learning stage. For example, the original design of the OHS group appeared to work fine with S2, S3 and S4, which were quite representative supplier factories in the supply base of FF in terms of their size and available resources for managing sustainability issues. These three suppliers thus established their OHS groups quickly and smoothly. In contrast, it took S1 longer to adapt the original design to the factory as an extra round of adjustments to the OHS group was needed to reduce its membership size. This was because the 35-member group established before the second factory visit caused difficulties for the majority of the members to carry on with their daily production responsibilities while at the same time taking on the duty of being an OHS group member. For example, S1-2 said, "We were a bit out of track in the first version of our OHS group when we mechanically applied the requirements…we had problems such as the group was too large, and not everyone could attend the all-day training because of their normal work duty. Then FF1 came and called a meeting with KP1 and me to configure and then finalise the structure of our OHS group". At the time when the groups were established, no proactive actions were found at the supplier organisations.

Entering the transformative learning process, it was found that suppliers gradually started to be more proactive in contextualising the OHS inspection routine and OHS inspection checklist to develop the OHS inspection routine. More specifically, suppliers went through the

loop of identifying issues (sensing), making decisions (seizing), and taking actions accordingly (reconfiguring), though how they transform the knowledge was found to be different across the four suppliers as each supplier has its own needs and focus. First, by revising the OHS inspection checklist, the suppliers identified gaps between the listed items and their actual situation. For example, S2 identified topic areas that they were particularly weak on when revising the inspection checklist, and thus asked KP2 to provide additional training sessions on these topics in the next factory visit. S2 thus went through an extra explorative and transformative learning cycle to identify risks associated with the two topics instead of moving straight onto the development of remediation actions, whilst the remaining three suppliers moved more quickly into remediation. This indicated that suppliers went into a loop where they started to identify the opportunities to learn new knowledge (sensing) in a more proactive way.

Second, all group leaders became aware of the potential benefits of running the OHS inspection routine and expressed their willingness to support the operationalisation of the SSD project, i.e. seizing the value of the knowledge and opportunities. For example, S3 regarded the SSD project and the established routine as an opportunity to reduce audit fatigue and allow the middle-management team to focus more on improving production efficiency rather than worrying about dealing with audits. S3-2 also mentioned that "I decided to communicate more with KP3 and maybe establish an evaluation mechanism for this in the future with the assistance of KP3 and the project to give us an opportunity to review our work". S3 also decided to apply the same pattern to a new factory site they were about to move to in a few months' time after the SSD project. In addition, S1 saw this SSD project as an opportunity to integrate OHS management into their organisational information system. Moreover, group members disseminated what they had learned from being an OHS group member to their own shop floor facilitating wider participation and buy-in to changes. For example, S4-3 sometimes had discussions about their OHS work with colleagues during morning discussions on his shop floor.

Third, the OHS inspection routines established at all four factories were comprised of regular inspections and meetings, closed-loop management of any detected OHS hazards, and reporting schemes. Meanwhile, continuous adjustments were made to the newly established routine at all supplier factories. For example, S3-2 mentioned that "we are still in a stage of trial and error at the moment. We are doing configurations and adjustments to the way we carry out the inspections and how we run the OHS group. We are trying to figure out a way that suits our factory best". Moreover, the frequency of inspections of S3 was adjusted according to the group's actual needs, while that of S1 was adjusted based on the workload of the factory.

4.2.3 Exploitative learning

Over the course of the SSD project, exploitative learning towards OHS management was facilitated at all four suppliers, though suppliers exploit the new knowledge differently according to their past experience and future plan. For example, as the project progressed, the suppliers proposed an idea to develop written guidance that records the key steps, events and materials of the project for further reference, though they identified different contexts for its use. More specifically, while S1 regarded this working guidance as a template for applying the same approach at some other factories belonging to the company, the remaining (smaller) suppliers S2, S3 and S4 viewed the guidance as a user manual for themselves and the other group members when carrying out the current OHS work. They saw this written guidance as being especially useful to knowledge retention as group members change over time. For example, KP2 mentioned that "at the last [final] factory visit, we also included the results of our discussion about staff turnover and OHS group member replacement into the written guidance for future reference".

In addition, as the project progressed, S1 realised that there was a need to develop some incentive strategies to encourage OHS group members to continuously fulfil their duties. S1 thus developed a rewards program with the support of top management, which was later found to also showcase the benefits of being involved in OHS management work to other workers that were not part of the OHS group. S1-3 mentioned that "I was the envy of my other colleagues when I brought the reward I got from redeeming the points I collected for fulfilling my OHS group member duties". Influenced by its past experience of OHS management, S4 came up with a plan to visualise the OHS work to present the progress that had been made and the issues that needed to be addressed to the entire factory. Meanwhile, to streamline the OHS inspection routine, S3 further simplified the inspection checklist and adapted the inspection frequency of the two group leaders. More specifically, the revised inspection checklist was divided into two different versions: one was used by group members to carry out fortnightly inspections by themselves and the other version was used by the group leaders to do regular checks and unannounced checks of the work done by all group members. FF1 also highly praised this practice.

4.2.4 Improvements in managing OHS issues

Towards the end of the project, all four suppliers began reporting fewer OHS risks and issues from the regular OHS inspections. This was also confirmed by the KPs. For example, after the

last factory visit, KP1 said "S1 went through a process in which they identified an increasing number of non-compliances in the first few OHS inspections and then a decreasing trend [of the number of non-compliances]. The focus now is to address the identified issues and prevent them from emerging again". Suppliers also reported an improved awareness in addition to inspection skills. For example, one of the shop floor workers (S2-3) had substantially improved both her awareness of identifying OHS risks and her ability to practice the duty as an OHS group member. She mentioned that "now I realise that I have the responsibility to report any risks I find during work…before [joining the group], I just felt that I was merely a worker to earn money from working here, these [OHS risks] were none of my business".

Meanwhile, the OHS group and the OHS inspection routine have been successfully integrated into the supplier organisations. For example, KP3, who mentioned that "I've checked the way the group [S3] do inspections and also the meeting minutes of their monthly meetings, so now I can say that the group is running smoothly and effectively, and this structure is well embedded in this organisation". Finally, this project helped with readiness for future audits and inspections, either by the supplier's customers or by other third parties. S1-2, for example, mentioned that "unlike in the past, I don't need to do a lot of preparations now when we have audits. I just need to post a notification to the group members and go and check with them before the audit. This has reduced the workload for me and the entire factory to a very large extent compared to before".

5. Discussion

This paper has studied the development of supplier absorptive capacity for sustainability through boundary objects in SSD projects from a knowledge transfer perspective, as summarised and conceptualised in Figure 3. The figure illustrates how the implementation of an SSD project via boundary objects can trigger the development of supplier explorative, transformative, and exploitative learning. Our results indicate that despite drawing on identical boundary objects, the four suppliers differed from each other in developing absorptive capacity for sustainability. More specifically, whilst explorative learning was characterised by the same ostensive aspects of the boundary objects given that the same buyer was involved for all four suppliers, transformative and exploitative learning were characterised by differing characteristics of the performative aspects. Thus, each of the four suppliers took a customised approach towards transforming and exploiting the knowledge gained to develop the boundary objects into consolidated organisational structures and routines in recognition of their local needs and contexts. Building on initial explorative learning, where suppliers passively sensed

the opportunities for change, the suppliers became more proactive as they went through the transformative learning and exploitative learning processes to sense and seize opportunities and reconfigure current practices for managing OHS issues.

[Take in Figure 3]

The prerequisite for a firm that wishes to make use of knowledge it is unfamiliar with is to invest dedicated effort exclusively in creating absorptive capacity for that new knowledge (Cohen and Levinthal, 1990). Prior literature has shown that SD projects and SSD projects are key drivers and sources of learning for suppliers and that buyers take a variety of actions to effectively transfer knowledge to suppliers (Hult et al., 2006; Modi and Mabert, 2007; Kim et al, 2015; Silvestre et al., 2020; Huo et al, 2021; Pereira et al., 2021). Our findings add to the prior literature by providing a supplier's perspective to illustrate how supplier absorptive capacity development is triggered and how buyers facilitate supplier learning processes that constitute their absorptive capacity via boundary objects. In particular, our research adds to the discussion of supply chain learning about sustainability (e.g. Pereira et al., 2021) by unpacking the process behind how suppliers enter the learning loop in the context of buyer-initiated sustainability initiatives. More specifically, in the context of SSD, by providing suppliers with sustainability-related boundary objects, the suppliers were pushed to start explorative learning, albeit in a passive way.

In addition, prior research (e.g. Silvestre et al., 2020) has suggested that explorative learning associated with new business process establishment resulting from sustainability initiatives allows supply chain sustainability capabilities to evolve in a radical way, generating long term benefits. Our research adds to this by showing the need to establish sustainability-related processes on the supplier side. More specifically, our findings show that assisting suppliers to establish new sustainability structures and routines allows suppliers to not only start to explore sustainability knowledge but also develop their capability to sense improvement opportunities. This is consistent with the dynamic capabilities literature showing that dynamic capabilities are derived from knowledge exchange between supply chain members (Roldán Bravo et al., 2020) and associated with processes that can create value for the firm (Sáenz et al., 2014). In addition, we add further granularity to the literature by showing the passive feature of the early stage of the dynamic capabilities development for sustainability in the context of SSD.

Moreover, since supplier learning is passive in the explorative learning process, our empirical results show that the information and knowledge disseminated are purely ostensive aspects of the boundary objects, which represent buyer requirements and goals for this SSD

project. This is consistent with the findings from previous literature that the ostensive aspects of boundary objects are sources of stability and standardisation (Feldman and Pentland, 2003; Biesenthal et al., 2019). In addition, our research extends prior research by highlighting the role of ostensive aspects in the explorative learning process in the context of SSD.

Therefore, our first set of propositions is:

Proposition 1a. Supplier entry into the learning loop during the explorative learning process is facilitated by the use of boundary objects in the context of SSD, during which the supplier starts to passively develop the capability to explore SSD-related knowledge and sense SSD-related improvement opportunities.

Proposition 1b. The ostensive aspects of the boundary objects dominate the explorative learning process given that supplier learning is passive at this stage.

This research adds further insight to transformative learning on the supplier side, complementing prior studies (e.g. Pereira et al., 2021) that have focused exclusively on explorative and exploitative processes in supply chain learning for sustainability. More specifically, our results show that the development of absorptive capacity on the supplier side centres on transformative learning, where suppliers start to proactively go through learning loops to identify new opportunities (sensing), make plans (seizing), and make necessary adjustments (reconfiguring) to the OHS group and OHS inspection routine. For example, S2 identified additional knowledge gaps during the transformative learning process and requested subsequent training sessions to address them. By highlighting the suppliers' shift from being passive during the explorative learning process to being proactive during the transformative learning process, our research shows how a supplier's dynamic capability for managing SSD-related sustainability issues is built and enhanced as suppliers go through the explorative and transformative learning processes. In doing so, this research complements prior studies on the antecedents, deployment, and outcomes of supplier dynamic capabilities (e.g. Sáenz et al., 2014; Biesenthal et al., 2019). Moreover, we also provide a nuanced understanding of the link between the development of absorptive capacity for internalising SSD-related knowledge and the development of dynamic capabilities for managing SSD-related sustainability issues, thus contributing to the broader dynamic capabilities literature (e.g. Teece, 2007).

In addition, the literature suggests that although the ostensive aspects of boundary objects ensure there is a unified input and standardised structure, they can constrain the flexibility of boundary objects to transfer knowledge (Feldman and Pentland, 2003). We add to this discussion by providing empirical evidence of the consequences of strictly adhering to the rigid

structure and standardisation of the boundary objects in the context of SSD. For example, for larger suppliers like S1, the OHS group would be too large to work efficiently if the firm strictly adhered to the structure dictated by the boundary object. Further, the effectiveness of knowledge transfer via boundary objects is also largely dependent on performative aspects, which are context-specific (Feldman and Pentland, 2003; Biesenthal et al., 2019). By showing that suppliers gradually integrate more of their own interests and needs, we add to the literature by identifying a shift in the dominant emphasis between ostensive and performative aspects during the transformative learning process and highlighting the dynamics of the relative importance of ostensive and performative aspects.

Therefore, we develop the following propositions:

Proposition 2a. During transformative learning, suppliers gradually and proactively develop their dynamic capabilities of sensing, seizing, and reconfiguring for managing SSD-related sustainability issues by contextualising and developing the boundary objects according to their own situation to establish new organisational structures and routines.

Proposition 2b. The impact of performative aspects of the boundary objects gradually becomes stronger while the impact of ostensive aspects gradually becomes weaker during transformative learning, as otherwise ostensive aspects could constrain the flexibility of the boundary objects in transferring and institutionalising knowledge in SSD.

The literature suggests that exploitative learning focuses on leveraging the transformed knowledge to create value (Sáenz et al., 2014). Our results confirm this by showing that all four cases successfully entered the exploitative learning process, for example by developing written guidance for further reference and to embed the OHS group and OHS inspection routine into their organisational routines. This guidance contributed to a sustained commitment to OHS work and learning, reducing audit fatigue. This was aided by the involvement of top/middle management staff, which provided the OHS group with the power to institutionalise particular practices they considered appropriate within the organisations, as proposed by prior literature (e.g. Feldman and Pentland, 2003). In addition, SSD research has also suggested that internal cross-functional groups facilitate knowledge transformation and organisational buy-in when making changes within the buyer organisation (Meinlschmidt et al., 2016). Our research extends this prior literature by showing that cross-functional groups, i.e. the OHS group consisting of top/middle management staff as well as shop floor workers, facilitate both organisational and individual buy-in for continuous change in terms of OHS management at supplier organisations. Thus, SSD-related learning momentum is sustained as suppliers

continuously utilise their new sensing, seizing, and reconfiguring capabilities as a catalyst to enter further learning loops.

Further, our results show that although the suppliers continuously deployed dynamic capabilities to identify further opportunities to improve the efficiency and efficacy of the OHS inspection routine, they differed from each other according to the knowledge and resources they exploited. For example, S1 and S4 developed new incentive strategies, i.e. a rewards program, S2 continued to fill knowledge gaps, and S3 worked on making the OHS inspection routine smoother. We thus extend the literature (e.g. Biesenthal et al., 2019; Silvestre et al., 2020) by showing that performative aspects take over during the exploitative learning stage where further improvements to the established OHS group and OHS inspection routine primarily depend on the specific course of action taken by each supplier.

Therefore, we propose the final set of propositions:

Proposition 3a. During exploitative learning, where new organisational structures and routines are embedded into organisational routines, suppliers sustain their SSD-related learning momentum by continuously using sensing, seizing, and reconfiguring capabilities as a catalyst to enter further learning loops.

Proposition 3b. The performative aspects of the boundary objects dominate the exploitative learning process when suppliers proactively exploit new knowledge based on their experience and needs.

6. Conclusions

This paper has adopted the absorptive capacity and boundary object lenses to examine knowledge internalisation on the supplier side of SSD projects. Focusing on the development of supplier absorptive capacity and the role of boundary objects has enabled an analysis of the dynamic and evolving nature of sustainability-related learning in supply chains. In doing so, the paper has responded to calls to investigate the processes and mechanisms behind sustainability-related supply chain learning and knowledge internalisation (Yang et al., 2019; Silvestre et al., 2020; Jia et al., 2021b), especially by suppliers in SSD projects within the supply chain.

More specifically, this paper contributes to the literature in three ways. First, our research contributes to both the absorptive capacity (e.g. Sáenz et al., 2014) and the dynamic capabilities literatures (Teece, 2007; Biesenthal et al., 2019) by focusing on the creation of absorptive capacity for sustainability, which is new knowledge for the supplier firm, and how this is linked to the creation of dynamic capabilities for managing sustainability issues. More specifically,

we have unpacked the development of supplier absorptive capacity in this context, showing how it is initiated and developed during SSD. In doing so, the paper has improved our understanding of the processes and outputs of supply chain learning in SSD projects from a supplier perspective. More specifically, our findings have shown that suppliers change from a passive approach to sensing external knowledge in the explorative learning process to a more proactive approach in the transformative and exploitative learning processes, where suppliers enter a loop of sensing and seizing the value of relevant knowledge before reconfiguring the process to internalise the knowledge.

Second, the paper has examined the knowledge transfer and learning processes during SSD projects, drawing on the construct of boundary objects. Specifically, this contribution stems from investigating both the ostensive aspects and the performative aspects of the boundary objects. To the authors' knowledge, this is the first paper to introduce the construct of boundary objects into the study of supplier learning processes to understand how knowledge transferred from the buyer to the supplier is internalised. In doing so, it opens up important avenues for further investigation of the knowledge flows between supply chain members using boundary theories and concepts. Meanwhile, by highlighting the need to facilitate the establishment of dedicated structures and routines in supplier organisations to sustain the impact of SD efforts, the study also explores the role of boundary objects in addressing barriers to supply chain learning, as called for by previous research (e.g. Yang et al., 2019).

Third, this study has examined the knowledge transfer and learning processes of suppliers in the context of SSD. More specifically, this research investigated the start of the learning process and, in more detail, the three specific learning processes, i.e. explorative, transformative, and exploitative learning that constitute the learning loop driven by SSD efforts. In doing so, the study also contributes to the wider SD literature (e.g. Modi and Mabert, 2007; Powell and Coughlan, 2020) by showing that learning loops triggered by SD efforts start with explorative learning. This finding contrasts with that of Pereira et al. (2021), who suggested that independently generated exploitative learning associated with prior certification/ accreditation processes comes first in the context of an unprecedented outbreak such as COVID-19, and thus this paper illustrates the unique nature of the SD/SSD context. Given that prior research has suggested that explorative learning can lead to more radical change (e.g. Silvestre et al., 2020), our study also reinforces the need to implement SD and SSD projects as they have the potential to have a major, long-term impact on suppliers.

6.1 Managerial implications

Our research has important managerial implications for both buyers and suppliers in terms of improving the effectiveness of SSD projects. Buyers should consider providing templates or tools to suppliers when implementing SSD projects in order to generate a strong and sustained impact on suppliers during and after a project. This is in addition to general training sessions or workshops. For example, the OHS group established in the SSD project under study became a concrete structure within the supplier organisations to help maintain learning momentum towards sustainability and diffuse knowledge to a wider audience, particularly the shop floor level. While templates and tools are valuable, there is no one-size-fits-all approach. Differences across suppliers, such as their size, need to be taken into consideration as this can affect whether suppliers are able to continue with the learning and practices for sustainability. Thus, there is a need to provide scope for sufficient flexibility in the design of rules and requirements associated with any boundary objects, to keep track of how boundary objects are actually used by suppliers, and to provide support and assistance when needed. Finally, for suppliers, SSD projects provide the opportunity to access sustainability knowledge, practices, and tools that they would not otherwise be able to access. Actively engaging in SSD to make the most use of the assistance provided can be beneficial for their sustainability performance in both the short-term and long-term. For example, the established OHS inspection routine and OHS group related to sustainability can help to reduce the burden of preparing for future audits, thereby contributing to overcoming the phenomenon of audit fatigue.

6.2 Limitations and future research

This research was limited to examining two particular boundary objects. Future research could be extended to other types of boundary objects and how they affect the knowledge transfer and learning processes in SSD projects. We have looked at suppliers' absorptive capacity from an organisational level perspective only; hence, learning and the development of absorptive capacity at multiple levels, including at the individual, organisational, and supply chain levels is an interesting direction for future study. Meanwhile, whether suppliers can benefit from SD initiatives also depends on relational characteristics, such as trust, and on cognitive characteristics, such as s shared understanding within the buyer-supplier dyad (Kim et al., 2015). Focusing on this aspect would enable a deeper understanding of the impact of relational characteristics on whether and how suppliers can effectively absorb the knowledge delivered by SD or SSD initiatives. It would also be interesting to see if any of the three learning processes that comprise absorptive capacity is more important and effective than the others in

different problem contexts. Finally, while our research has adopted a supplier perspective, further analysis could be undertaken from a triadic perspective by examining the roles of the buyer, external knowledge provider, and supplier to evaluate how the interactions between all three players impact supply chain learning towards sustainability.

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Table I. Indicators of research quality in this study: Validity and reliability

Criteria	Research phase			
	Design	Case selection	Data collection	Data analysis
Construct validity (*suitable measures for the concepts being studied*)	- Multiple rounds of data collection to illustrate the changes and developments in the SSD process - Longitudinal case study to explore the learning processes	- N/A	- Multiple sources of information: interviews, observation notes and documentary data throughout the project - Two rounds of interviews focused on the start and the development of the learning processes	- Triangulate data from multiple sources - Data coding in an abductive way to allow for emerging topics - Case study report validated by informants to avoid researcher bias
Internal validity (*causal relationships between variables and results*)	- Select a highly relevant industry with major social sustainability risks	- N/A	- Choose the most knowledgeable informants as interviewees from multiple actors	- Record alternative explanations - Interviews fully transcribed and sent to interviewees for validation - Go back and forth between the data and the literature to avoid researcher bias
External validity (*generalizability of the findings*)	- Multiple case study design - Draw on well-established absorptive capacity and boundary object constructs	- Literal sampling using replication logic	- Conduct interviews with multiple informants from each supply chain actor	- Analytic generalization: emerging concepts and patterns shed light on suppliers' use of absorptive capacity via boundary objects in SSD
Reliability (*replicability of the research design and results*)	- Develop a case study protocol and database	- Record the case selection criteria	- Develop two semi-structured interview schedules, each with a different focus and record all interviews - Keep a written record of the observation notes and the documents reviewed	- Data coded and interpreted by multiple researchers - Keep a record of the coding process in N-Vivo

Table II. Information on the firms, interviewees, interviews, project meetings, and factory visit reports

Firm; company profile/product category	Firm size; OHS group size	Business dependence; relationship length	No. of interviews of each firm in total		Interviewee; role in this project	No. of interviews	Total interview time for interviewee	Project meeting observations/ factory visit reports reviewed
			Project beginning	Project end				
Fast fashion brand and retailer (FF), Fast fashion retailer	n/a	n/a	2	2	FF1, Project manager	2	152 min	Attended and observed 5 project meetings, spread over a 12-month period (total of 341 minutes)
					FF2, Project advisor	2	131 min	
External knowledge provider (KP), Consultancy	n/a	n/a	5	4	KP1, Consultant for S1&S4	3	123 min	
					KP2, Consultant for S2	2	96 min	
					KP3, Consultant for S3	2	78 min	
					KP4, Consultant for S1&S4	2	43 min	
Supplier factory 1 (S1), Accessories	418 employees, 18 members	40%, 10 years	7	4	S1-1, OHS group leader	2	27 min	Reports for 5 factory visits, spread over a 12-month period, + 1 final report (22 pages)
					S1-2, OHS group leader	3	83 min	
					S1-3, OHS group member	2	27 min	
					S1-4, OHS group member	2	27 min	
					S1-5, OHS group member	1	16 min	
					S1-6, OHS group member	1	10 min	
Supplier factory 2 (S2), Homeware	70 employees, 10 members	60%, 10 years	6	5	S2-1, OHS group leader	2	52 min	Reports for 5 factory visits, spread over a 12-month period, + 1 final report (20 pages)
					S2-2, OHS group leader	2	38 min	
					S2-3, OHS group member	2	18 min	
					S2-4, OHS group member	2	36 min	
					S2-5, OHS group member	2	20 min	
					S2-6, OHS group member	1	25 min	
Supplier factory 3 (S3), Electronics	51 employees, 6 members	30%, 8 years	4	3	S3-1, OHS group leader	2	34 min	Reports for 5 factory visits, spread over a 12-month period, + 1 final report (20 pages)
					S3-2, OHS group leader	2	62 min	
					S3-3, OHS group member	2	21 min	
					S3-4, OHS group member	1	28 min	
Supplier factory 4 (S4), Homeware	54 employees, 8 members	10%, 2 years	4	4	S4-1, OHS group leader	2	26 min	Reports for 5 factory visits, spread over a 12-month period, + 1 final report (21 pages)
					S4-2, OHS group leader	2	40 min	
					S4-3, OHS group member	2	22 min	
					S4-4, OHS group member	2	28 min	

Table III. Supplier absorptive capacity development process towards OHS management

Learning stages	The status of the boundary objects		Sample of key quotes	Characteristics of this learning process
Explorative learning	Boundary objects created by the buyer	The concept of the OHS group	Our aim is to help the factory to establish an effective OHS group which is consisting of staff from each responsibility area (FF1). For the factories, it is actually to select a group of people to construct the group that will be in charge of the OHS management for the entire factory (KP2).	The suppliers passively started the project to receive knowledge from the buyer via the boundary objects.
		The inspection checklist	In terms of the knowledge we would like to deliver to our suppliers, this project will focus on the 50 items listed in the inspection list (FF1). The scope of this project is defined by the inspection checklist developed by the brand. This checklist is developed based on the common issues identified from past audits for its supply base (KP1).	
	Boundary objects transfer mechanism	Training sessions and assignments	He [KP1] came to deliver training to the selected members. The training is very professional and very informative (S1-2). We had a whole day training, during which the teacher told us what we are expected to do and how to use the inspection checklist (S2-1). I covered topics such as the requirements of the OHS group. I got to know the situation of the factory and also alleviated their concerns for this project (KP3). We were not sure about some items in the checklist and the teacher explained them in more detail in terms of what we should do and aim to achieve (S4-2).	
	Accept the boundary objects	Start to establish the initial structure of the OHS group	The group member list is still waiting for further amendment because I misunderstood the required structure of the OHS group (S1-2). He [KP2] helped us to establish an original version of the OHS group and also provided some instructions and suggestions to us regarding what is OHS (S2-2). She [KP3] helped us to select the group members and had a look at the actual situation of our factory (S3-1). This time the teacher [KP4] came to help us establish the group and she asked me to call a meeting for us all to emphasise the importance of this project and encourage our group members to actively engage (S4-1). The pandemic delayed the implementation of this project and when everything resumes, this factory (S4) needs to relocate to another factory site (KP4).	

Transformative learning				
	Develop the boundary objects into organisational structures and routines	Clarify the OHS group concept and responsibility	My duty includes three main aspects: to facilitate, to monitor and to provide support and resources for the entire group (S1-1). I now realise that I am also a part of the group and the factory. I have the responsibility to spot and report issues in my responsibility area (S2-3). We also had a discussion around the individual responsibility of each group member and the group leaders (KP3). We assigned the responsibility to each of the group members (S4-2).	Transformative learning requires more time and effort from the suppliers and is the primary learning process. All suppliers showed some level of proactive learning, which indicates a shift from passively receiving knowledge from the buyer and KPs to proactively searching for knowledge relevant to OHS management. Learning and practices in this process focus on contextualising the boundary objects under the guidance of the buyer and the KP.
		Revise the inspection checklist	The original checklist does not fit the actual situation of S1, the group members didn't know how to use it. So I asked them to first revise the checklist (KP1). The checklist has been revised to fit our packaging floor, the teacher [KP2] asked us to remove irrelevant items (S2-3). My leader provided an updated checklist with follow-up actions needed for each of our group members and asked us to use it (S3-3). I helped the factory to divide the items into different categories according to the required inspection frequency. The checklist is handier (KP4).	
		Establish the inspection routine	All the factories now have a pretty much settled inspection routine (FF1). We have an inspection within my floor every week. Issues found will be reported to the group leader immediately and follow-up corrections will start (S1-3). I'm collecting the inspection results for last month. I'll make a plan regarding how to address the issues detected and delegate the duty to relevant group members (S2-2). We now have established an inspection routine. The group members now carry out OHS inspections twice every month. In addition, I do unannounced double checks (S3-2). I will report to my leader once I spot any issues and start to find solutions (S4-4).	
	Identify new learning opportunities	Identify additional knowledge gaps	We are thinking: which aspect would we like the teacher to focus on for the next factory visit? We'll discuss this with the teacher before he comes to visit us (S1-1). I'm still not very clear about what the teacher [KP2] said about chemical classification and would like the teacher to give more details next time (S2-6). As a female worker, I'd like to know more about the knowledge relevant to female worker protection (S3-3). I feel like I want to know more about the laws & regulations and procedural documents for OHS work because I'm still a bit confused about this stuff (S4-2).	
		Identify opportunities to improve current practice	I think I can also engage the staff on my floor to carry out the OHS work together (S1-4). By doing the inspections, we can also identify opportunities to improve our production routine and facilities (S2-2). I think the key to this OHS group is to engage the group members, and I'd like the teacher to give us more advice on that (S3-1). I'll cover some of the key points into the daily meeting within my floor to let more people know about this [OHS] work (S4-3).	

Exploitative learning	Advance the structures and routines	Incorporate the inspection routine into organisational routine	My goal is to develop a solid and operationalised procedure for the OHS group and to make it a formal structure that can operate effectively and sustainably (S1-1). I'm planning to divide my responsibility area into some sub-areas and ask those staff who report to me to be aware of respective sub-areas, I believe this will work better as we have both a day shift and night shift (S2-6). What we are planning to do is to make the OHS work a part of their job responsibility rather than extra or additional workload (S3-1). It is just about being aware of OHS issues, to report in a timely way, and to sort it as soon as possible. OHS is of great importance to us all, anyway (S4-4).	The suppliers continuously identify opportunities for improving learning and practice efficiency, primarily based on their past experience, current needs and future development goals.
		Develop cross-area inspection scheme	We have come up with an idea of cross-area inspection to make the inspections not so boring and also more effective (S1-1). I think it is more effective to do cross-area inspections as we may overlook issues within our own areas (S1-4).	
		Streamline the OHS inspection routine	Each member got a simplified one-page checklist that was only relevant to his or her responsibility on the front page and a form to record any follow-up needs and actions on the back page of the checklist…There are also two versions of the checklist to cater for the different needs of the group leader and group members (KP3).	
		Visualise OHS work	We had experience of visualisation a few years ago to meet clients' requirements and, this time, we would like to make the visualisation more systematic (S4-1). We would make the issues we found from inspections visible within the shop floors to let people be aware of those issues and then try to avoid them (S4-2).	
		Develop incentive strategy	We developed a rewards program. Basically, we will give points to a group member upon addressing the issue he or she identified during inspections. They can redeem the points for daily necessities every two months (S1-2). We developed an rewards program specifically for the OHS group to encourage group members to carry out inspections (S4-2).	
		Develop working guidance for future reference	We developed a document which records key steps of this project and also the design of the incentive strategy. It works as a guidance for us to carry on with OHS work in this factory and to copy the same pattern to other factories (S1-2). A working guidance has been finalised during the last factory visit; this document can work as a guideline for the future work of the OHS group (KP2). We'll apply the established routine to our new factory (S3-1). They [S4] have developed working guidance and all the group members are actively carrying out their work based on the guidance (KP4).	

Figure 1. Coding structure

Theoretical constructs **Themes** **Codes** **Sub codes**

Explorative learning
- Boundary objects created by the buyer
  - The concept of the OHS group
  - The inspection checklist
- Boundary objects transfer mechanism
  - Training sessions and assignments
- Accept the boundary objects
  - Start to establish the initial structure of the OHS group

Transformative learning
- Develop the boundary objects into organisational structure and routine
  - Clarify the OHS group concept and responsibility
    - Clarify individual responsibility
    - Finalise the OHS group structure
  - Revise the inspection checklist
    - Revised checklist based on the original version
    - Continuous update of the checklist based on inspections
  - Establish the inspection routine
    - Address the problems emerged during carrying out inspections
    - Establish working process, meeting frequency, and time spent on inspections
- Identify new learning opportunities
  - Identify additional knowledge gaps
  - Identify opportunities to improve current practice

Exploitative learning
- Advance the structure and routine
  - Incorporate the inspection routine into organisational routine
  - Develop cross-area inspection scheme
  - Streamline the OHS inspection routine
  - Visualise OHS work
  - Develop incentive strategy
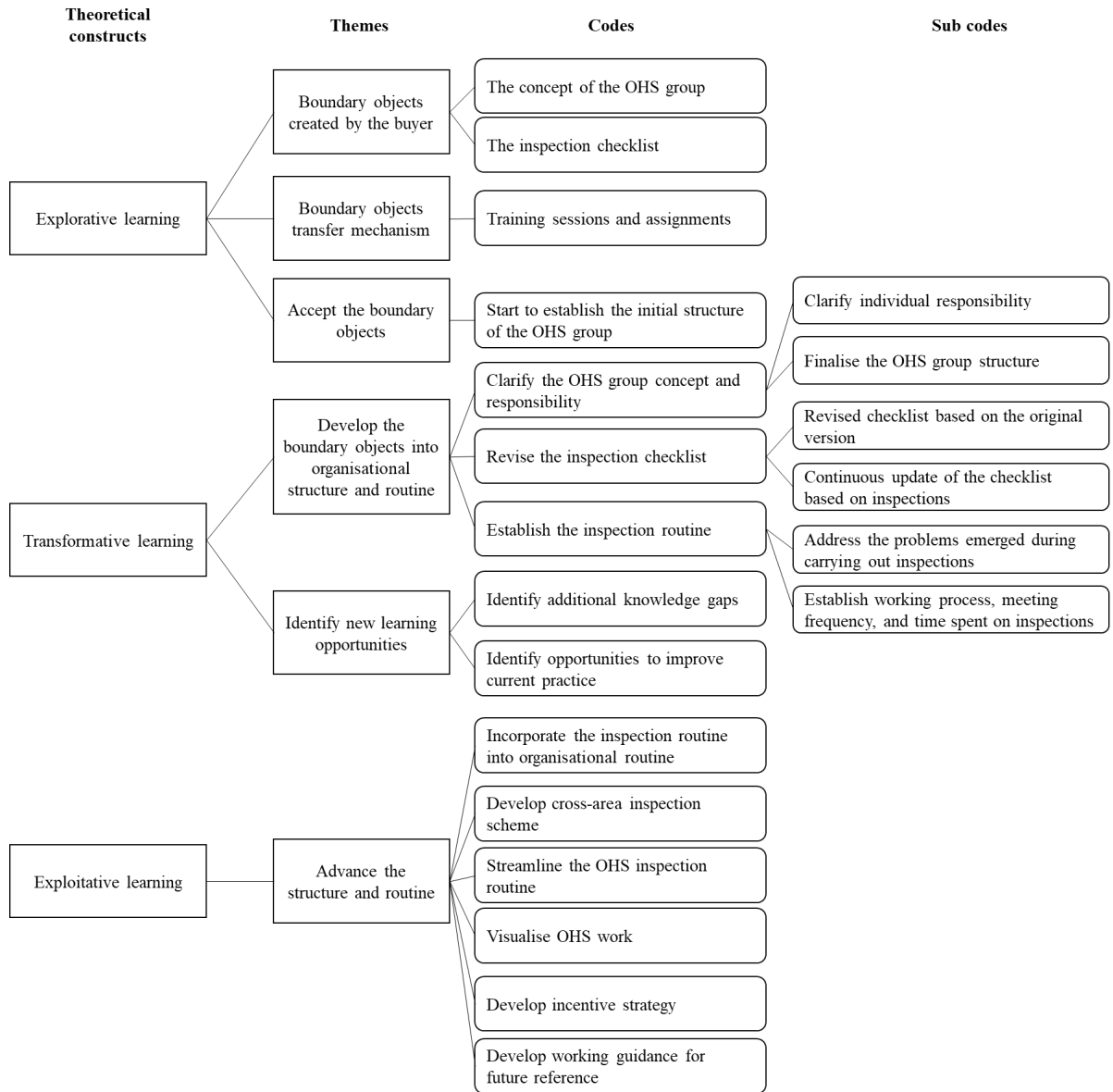 - Develop working guidance for future reference

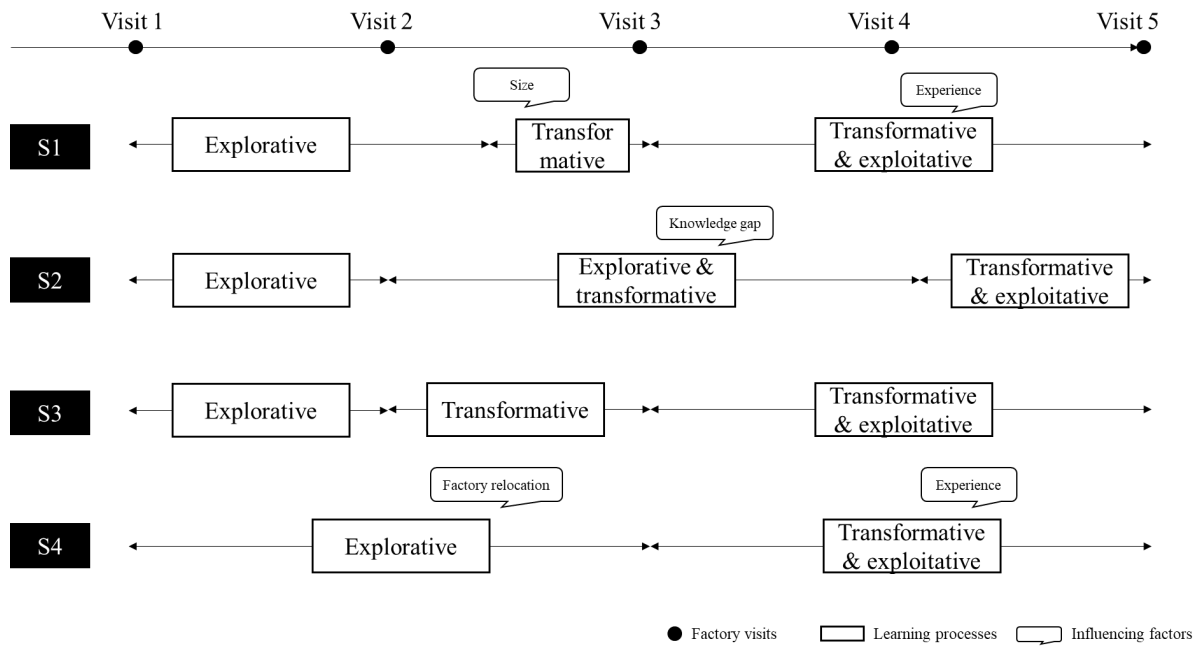Figure 2. The development of supplier absorptive capacity over time

Figure 3. The development of suppliers' absorptive capacity for sustainability via boundary objects in SSD