# Building routines for non-routine events

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# Building routines for non-routine events: supply chain resilience learning mechanisms and their antecedents

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## Abstract

**Purpose** – Organisations must build resilience to be able to deal with disruptions or non-routine events in their supply chains. While learning is implicit in definitions of supply chain resilience (SCRes), there is little understanding of how exactly organisations can adapt their routines to build resilience. The purpose of this study is to address this gap.

**Design/methodology/approach** – This paper is an in-depth qualitative case study based on 28 interviews across five companies, exploring learning to build SCRes.

**Findings** – This study uncovers six learning mechanisms and their antecedents that foster SCRes. The learning mechanisms identified suggest that through knowledge creation within an organisation and knowledge transfer across the supply chain and broader network of stakeholders, operating routines are built and/or adapted both intentionally and unintentionally during three stages of a supply chain disruption: preparation, response and recovery.

**Practical implications** – This study shows how the impact of a supply chain disruption may be reduced by intentional and unintentional learning in all three disruption phases. By being aware of the antecedents of unintentional learning, organisations can more consciously adapt routines. Furthermore, findings highlight the potential value of additional attention to knowledge transfer, particularly in relation to collaborative and vicarious learning across the supply chain and broader network of stakeholders not only in preparation for, but also in response to and recovery from disruptions.

**Originality/value** – This study contributes novel insights about how learning leads both directly and indirectly to the evolution of operating routines that help an organisation and its supply chains to deal with disruptions. Results detail six specific learning mechanisms for knowledge creation and knowledge transfer and their antecedents for building SCRes. In doing so, this study provides new fine-grained theoretical insights about how SCRes can be improved through all three phases of a disruption. Propositions are developed for theory development.

**Keywords** Supply chain resilience, Learning mechanism, Disruption, Routines

**Paper type** Case study

## 1. Introduction

While it is possible to mitigate some supply chain risks, there will always be situations when current practices and processes offer no adequate predetermined response – non-routine events (Nelson and Winter, 1982). Supply chain disruptions are non-routine events experienced by 75 per cent of all organisations each year (Business Continuity Institute, 2013). Accepting that supply chain disruptions are inevitable, organisations must *learn* to adapt their routines and procedures to foster supply chain resilience (SCRes), i.e. the adaptive capability that minimises the impact of a non-routine event by pro-actively identifying strategies that enable the supply chain to react to and recover from such incidents (Jüttner and Maklan, 2011). For example, while Cisco was unable to locate products in its supply chain in time to respond to a tremendous surge in demand for telecommunications equipment caused by Hurricane Katrina in 2005, six years later, when a tsunami and earthquake in Japan caused one of the largest disruptions to

global supply chains of the twenty-first century, Cisco's supplies were barely impacted (Sáenz and Revilla, 2014). Cisco learnt from its experiences from Hurricane Katrina, that is, Cisco built new routines to be resilient to non-routine events.

Several studies have established that learning from prior experience can prompt an organisation to adapt its routines to better respond to that particular disruption and to similar events in the future (e.g., Fiksel et al., 2015; Pettit et al., 2010). In addition, training and development programmes have been shown to develop risk-mitigation capabilities (Ritchie and Brindley, 2007). As such, learning from non-routine events is a key feature of SCRes (Pettit et al., 2010; Ponomarov and Holcomb, 2009). Yet, in spite of the confirmed relationship between learning and SCRes (Chowdhury and Quaddas, 2016), we still understand little of what enables organisations to adapt routines and foster SCRes when dealing with non-routine events (supply chain disruptions). Research suggests that inter-organisational learning leads to enhanced SCRes (Manuj and Mentzer, 2008), but to date, the mechanisms implicit in building/adapting routines for SCRes internally within the organisation, and externally with upstream/downstream supply chain members and other stakeholders, have not been explicitly theorised. In response, we ask *how organisations use learning mechanisms to build SCRes: routines for non-routine events.*

In addressing this gap, we draw on seminal work by Zollo and Winter (2002) and Teece et al. (1997), conceptualising how learning enables the development of dynamic capabilities such as SCRes (Chowdhury and Quaddus, 2017; Johnson et al., 2013). Our findings from multiple case studies allow us to make three important contributions. First, we identify six specific learning mechanisms for building SCRes and their antecedents. Previously, how supply chains adapt to non-routine events (i.e. learn to build resilience) has been treated as a black box, and the underlying mechanisms remained elusive. This study reveals how knowledge creation and knowledge transfer across the supply chain and stakeholder network allow for learning across all three supply chain disruption phases (preparation, response, recovery). As such, learning is not limited to the post-disruption stage, as previously suggested (e.g., Pettit et al., 2010). Second, this research establishes a more fine-grained perspective of learning for SCRes, extending our understanding of how routines are both intentionally and unintentionally adapted. In identifying the antecedents of unintentional learning, we unveil the dynamics of how unintentional learning is converted into intentional learning. Third, we contribute a much-needed understanding of how managers can learn from disruptions to transform unexpected and generally negative events into positive opportunities for building, adapting and extending routines to foster SCRes.

## 2. Literature review and theoretical framework

Routines are recurring patterns of organisational responses, involving individuals or groups and interdependent activities that become reinforced through structural embeddedness and repeated use (Feldman and Pentland, 2003; Nelson and Winter, 1982). As knowledge repositories, routines embody organisational memory, whether in the form of written rules, technologically determined courses of action or experience-based tacit understandings of the right course of action (Grote et al., 2009). At the same time, organisational routines also encompass behavioural patterns that are not explicitly guided by written rules and policies (Peng et al., 2008). Routines are not static (Pentland and Feldman, 2005) but can be adapted and regenerated to achieve organisational flexibility and change (Feldman and Pentland, 2003; Miller et al., 2012).

Adaptation of organisational routines is particularly necessary in responding to a non-routine event (Feldman, 2000). Organisations typically continue to follow existing routines until a gap appears between the organisation's objectives (e.g. continuous flow in the supply chain) and outcomes (e.g. a disruption in the supply chain) (Cyert and March, 1963; Feldman and Rafaeli, 2002). Supply chain disruptions are unanticipated non-routine events impacting the flow of goods, materials and/or services at any tier of the supply chain (Craighead et al., 2007); they may directly influence an organisation's ability to bring finished goods to the market and/or provide critical services to customers (Jüttner, 2005) or may indirectly lead to a loss in shareholder value, such as through reputational damage (Hendricks and Singhal, 2005).

### 2.1 Supply chain resilience
Recognition that some organisations recover from non-routine events such as industrial action, extreme weather and IT breakdowns quicker than others is prompting growing attention to the concept of SCRes – defined here as the adaptive capability of an organisation to prepare for, respond to and recover from any type of supply chain disruption (Fiksel et al., 2015; Ponomarov and Holcomb, 2009). SCRes is assessed in relation to the three phases of a disruption: preparedness (pro-active, before an event), response and recovery (re-active, after an event) (Ali et al., 2017; Pettit et al., 2010). Theory provides alternative perspectives on the formative elements required to build an organisation's adaptive capability for SCRes. For example, Jüttner and Maklan (2011) conceptualise SCRes' formative elements as flexibility, collaboration, visibility and velocity, Wieland and Wallenburg (2012) define this adaptive capability in terms of robustness and agility and Christopher and Peck (2004) and Scholten et al. (2014) take a system-level approach identifying a combination of supply chain (re-)engineering, collaboration, agility, risk awareness and knowledge management. At the same time, supply chain visibility (Brandon-Jones et al., 2014), supply chain collaboration (Scholten and Schilder, 2015), supply chain orientation and a learning and risk management culture (Chowdhury and Quaddas, 2016) are also considered to be antecedents of SCRes. For a complete overview of SCRes strategies and capabilities, see reviews from Tukamuhabwa et al. (2015), Hohenstein et al. (2015), Kamalahmadi and Parast (2016) or Ali et al. (2017). The field of SCRes has also been further developed by applying, testing and exploring various strategies and capabilities in different contexts, such as agricultural supply chain (Stone and Rahimifard, 2018), developing countries (Tukamuhabwa et al., 2017) or the oil and gas industry (Urciuoli et al., 2014).

While there are differences in identifying the formative elements of resilience, it is generally acknowledged that these

elements combine to develop the adaptive capability of an organisation (SCRes) based on bundles of routine practices (Birkie *et al.*, 2017). At the same time, when a disruption occurs, organisations need to adapt their routines to respond to and recover from "experience by modification of its [in this case the organisation's] technologies, forms and practices" – the definition of learning by Levinthal and March (1993, p. 96). Accordingly, it has been suggested that learning and growth represent a fourth phase of resilience after the recovery stage (Adobor and McMullen, 2018; Hohenstein *et al.*, 2015) via learning from experiences (Pettit *et al.*, 2010) or training and development (Blackhurst *et al.*, 2011; Ritchie and Brindley, 2007). Yet, in spite of this acknowledgement of the role of learning for SCRes (Chowdhury and Quaddas, 2016), how organisations can learn and adapt their routines to foster SCRes has not been explicitly theorised.

## 2.2 Learning

Following Levitt and March's (1988) seminal work, and definition of learning as the embedding of knowledge acquired from experience into routines that guide behaviour, we argue that organisational learning occurs if, through the processing of information or experience, the range of potential behaviour (observable and unobservable) is adapted or changed (Huber, 1991; Lampel *et al.*, 2009). As such, learning encompasses both the relatively passive experiential processes of "learning by doing" and the more deliberate cognitive processes of articulating and codifying collective knowledge (Zollo and Winter, 2002). This can occur intentionally, but more frequently unsystematically or unconsciously (Huber, 1991).

There are two means by which organisational learning may be achieved: knowledge creation through critical internal analysis and experience and knowledge transfer through leveraging knowledge across boundaries. For example, knowledge transfer can occur across occupational groups, organisational units or other supply chain members and stakeholders (Argote and Miron-Spektor, 2011; Hora and Klassen, 2013; Spender, 1996) outside immediate dyadic relationships (Manuj and Mentzer, 2008) as dysfunctional routines are recognised (Teece *et al.*, 1997). While individuals create and transfer knowledge, i.e. learn, it is not sufficient for group or organisational learning to take place (Argote and Miron-Spektor, 2011). Organisational learning mechanisms facilitate the accessibility of knowledge through the accumulation, codification and sharing of individual experiences (Huang *et al.*, 2008; Zollo and Winter, 2002) and the transfer of these into organisational routines (Argote and Miron-Spektor, 2011). By these means, knowledge is raised from the individual to the group and ultimately to the organisational level (Heimeriks *et al.*, 2007). General theories of learning identify various learning mechanisms. For example, Huber (1991) identifies congenital learning, experiential learning, vicarious learning, grafting and searching and noticing; Pisano (1994) refers to learning by doing and learning before doing. In the humanitarian aid context, Lu *et al.* (2013) uncovered learning by searching, learning by hiring, learning by doing and learning by observation, and Heimeriks *et al.* (2007) investigated 29 mechanisms that were seen as critical to alliance capability development. As such, there is considerable

literature on general learning mechanisms and on learning mechanisms in specific contexts. Nevertheless, how SCRes can be enhanced through learning mechanisms to adapt/create routines has been largely overlooked.

In their pioneering work on the evolution of routines, Zollo and Winter (2002) conceptualise learning mechanisms as enabling operating routines to evolve both directly and indirectly through existing dynamic capabilities. Dynamic capabilities represent an organisation's "ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece *et al.*, 1997, p. 516). As such, the resilience capabilities of an organisation and its supply chains to overcome disruptions can be considered a dynamic capability (Chowdhury and Quaddus, 2017). We bring together this perspective of SCRes as a dynamic capability (Brusset and Teller, 2017; Chowdhury and Quaddus, 2017; Johnson *et al.*, 2013) with the implicit role of learning in SCRes (Chowdhury and Quaddas, 2016; Pettit *et al.*, 2010; Ponomarov and Holcomb, 2009) and the work of Zollo and Winter (2002) on the evolution of routines. Accordingly, Figure 1 captures Zollo and Winter's (2002) framework in the context of SCRes. In particular, it shows the pre-established relationship between learning mechanisms that shape operating routines directly (via knowledge creation and transfer) or by the intermediate step of dynamic capabilities (here SCRes) (Zollo and Winter, 2002). Furthermore, Figure 1 also illustrates the pre-established relationships from the SCRes literature, i.e. that formative elements build the adaptive capability of SCRes and that these formative elements are based on bundles of operating routines (Birkie *et al.*, 2017) that inherently change if routines are modified (Tukamuhabwa *et al.*, 2015). In summary, while the literature highlights that learning is an inherent part of SCRes (Chowdhury and Quaddas, 2016; Tukamuhabwa *et al.*, 2015), it falls short of empirically identifying the mechanisms through which learning can occur. Accordingly, we investigate how organisations use learning mechanisms to build SCRes.

## 3. Methodology

### 3.1 Research design

We used a multiple case research design to address our research question as it is particularly suited to investigate a real-life (complex, unique, exploratory) phenomenon, such as SCRes, in depth (Yin, 2009). We define our embedded unit of analysis as a disruption (non-routine event) in the

**Figure 1** Conceptual model of SCRes learning (drawing on Zollo and Winter, 2002)
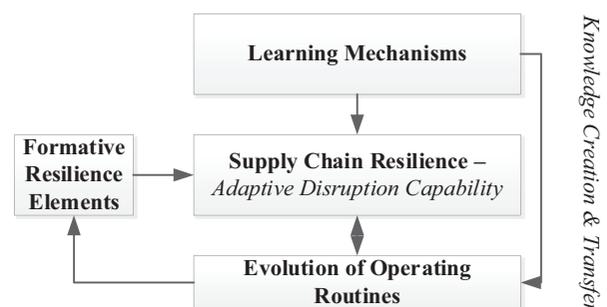
supply chain of five case organisations to identify the learning mechanisms for building the adaptive capability required to prepare for, respond to and recover from the event (i.e. to build resilience).

To allow us to draw conclusions on resilience in supply chains, we decided to use extreme cases as these can offer potent depictions of some of the target phenomenon's characteristics (Scholten *et al.*, 2014). With this in mind, we selected four organisations active in disaster management as this field has to frequently deal with breakdowns and interruptions in material and information flows (Blecken, 2010). The selection of case organisations for this study was evolutionary and based on theoretical replication (see Table I) (Yin, 2009). As such, besides selecting four organisations active in disaster management, we also selected one organisation outside this sphere. We specifically sought variety in organisational motives and practices. Cases range along a continuum from commercial (service providers and manufacturers) to not-for-profit (service providers) networks with various backgrounds, focus, size, geographical location and approaches to dealing with risk. The case organisations are named here as Red, Green, Yellow, Blue and Purple, and specific details relating to their locations and the names of

managers and organisations are disguised to preserve anonymity.

### 3.2 Data collection

The core data of this study are made up of 28 semi-structured interviews across five different organisations. We selected individuals in the headquarters of the organisations (blue is an exception as it is a local organisation) to ensure that we can draw on data that link to the global supply chains of the organisation, ranging from procurement to distribution, rather than fragments of them. Furthermore, the interviewees selected were expected to have an understanding of supply chain management and supply chain flows (i.e. material, service, information and money) before, during and after a disruption. We arranged individual semi-structured interviews (typically one-hour duration) over a two-year period. We sought multiple viewpoints from within the organisations (volunteers, operational staff, functional managers and senior management (see Table I) to enable a deep and informed understanding of specific situations and reactions in relation to non-routine events. All but two of the interviews were conducted personally and were recorded and transcribed verbatim by the researchers. The two remaining interviews were conducted via Skype face-

**Table I** Case criteria

| Case | Category of organisation | No. of employees | Scope of operations | Offers | Approach to risk | Position of the interviewees |
|------|--------------------------|------------------|---------------------|--------|------------------|------------------------------|
| **Red** | International not-for-profit | >3,000 | >25 countries | Services | Accepts risk in the delivery of goods/ services | A. HR manager<br>B. Logistics advisor<br>C. Suppliers and logistics manager<br>D. Finance manager |
| **Green** | Multilateral not-for-profit | >11,000 | >190 countries | Services | Risk-adverse | A. Supply chain specialist<br>B. Contract manager<br>C. Supply chain specialist<br>D. Logistics specialist<br>E. HR manager |
| **Yellow** | Commercial | >600 | >15 countries | Services | Entrepreneurial | A. Field operations manager<br>B. Supply chain manager<br>C. Head of marketing/ director of community development<br>D. Business development manager<br>E. Engineering manager<br>F. COO |
| **Blue** | Local not-for-profit | 28 organisations | National | Services | Exists to mitigate vulnerability | A. Finance specialist<br>B. Disaster services manager<br>C. Executive director<br>D. Preparedness health and safety specialist<br>E. Shelter and case worker, volunteer<br>F. Vice president<br>G. Administration coordinator (finance/ HR)<br>H. Community support relations director |
| **Purple** | Commercial | >10,000 | >100 countries | Fast-moving consumer goods | Risk-adverse | A. Head of SCM and logistics<br>B. Supply chain planning manager<br>C. Head of international customer service centre<br>D. Planning manager<br>E. International customer service centre division manager |

to-face calls. Where necessary, follow-up e-mails and phone calls with interviewees were used to add missing details.

An initial literature review guided the development of the interview protocol. All interviews began with general questions to establish the background and position of the interviewee, the strategic setup of the organisation and the role and strategic importance of supply chain management in the overall decision-making process of the organisation. The main part of the interviews followed a standard protocol (to facilitate data comparison) organised under broadly defined themes, with open-ended questions and probing follow-up questions to encourage detailed responses. We posed questions related to supply chain disruptions that had happened, risk management procedures, collaborations and need for improvements. Interviewees were asked to recall specific disruptions and reflect on learning that happened in relation to the event either within the organisation or in collaboration with supply chain members or other stakeholders. Additionally, to allow for internal triangulation, we observed a one-hour disaster-preparedness meeting in which participants engaged in a table-top exercise simulating a disruptive event (illustrative of learning from and within the broader network) and reviewed secondary and archival sources for additional details on the examples and illustrations provided by the interviewees.

### 3.3 Data analysis

Drawing on the well-established literature streams on organisational learning and SCRes, we chose a deductive approach for the data-analysis process. We started by grouping and coding the transcribed raw data (words, sentences and paragraphs) in the examples provided by the interviewees in relation to *changes in behaviour* - i.e. learning (Huber, 1991) (first-order codes). The data analysis then progressed through multiple phases. As behaviour is adapted/changed either through critical internal analysis and experience (knowledge creation) or by leveraging knowledge across boundaries through the communication of knowledge (knowledge transfer) (Argote and Miron-Spektor, 2011; Hora and Klassen, 2013; Spender, 1996), we initially deduced second-order categories from the first-order codes by searching for the learning processes of knowledge creation and transfer (see Table II for representative data for each of these codes). Knowledge creation situations were seen as the active formation of knowledge by combining stored information with new information from the environment (Raisinghani and Meade, 2005). Situations coded under transferring knowledge were those related to the intentional sharing of knowledge between different supply chain tiers, other stakeholders or business units where one party within the network (focal organisation or business unit) learns from the other. Such transfer of knowledge occurred not only between the focal organisation and its suppliers and between the focal organisation and other units of the organisation (such as between headquarters and in country offices) but also between the focal organisation and competitors or a government. This allowed us to capture learning from the broader network of the organisations. While this transfer of knowledge could also incorporate the creation of new, shared knowledge, we did not code any such examples a second time under knowledge creation. Initially, our intention was to investigate learning as a separate, fourth phase of SCRes.

Yet, we observed during the first coding steps that learning could be linked not only to learning from experience i.e. after a disruption, but also to the preparation and response phase of a disruption. Accordingly, we deduced second-order categories from the first-order codes following the structure of the adaptive SCRes capability that enables the organisation to prepare for, respond to and recover from disruptions (Ponomarov and Holcomb, 2009) (see Table II for representative data for each of these codes). Here, behavioural changes that occurred prior to a disruption were coded as preparedness, at the moment of a disruption as response and after a disruption as recovery. We specifically looked for changes in the organisations' operating routines that could be linked to various SCRes formative elements (see Tukamuhabwa *et al.*, 2015), and examples can be found in Figure 2 below. These coding steps were undertaken for each individual case to enable unique patterns to emerge (Yin, 2009).

Finally, the data were inductively analysed seeking cross-case patterns. We juxtaposed the two deduced second-order categories and searched for antecedents of the learning that had occurred (third-order themes). As such, these antecedents give insights into the underlying mechanisms that triggered learning. The antecedents were then aggregated into six learning mechanisms based on already established learning mechanisms whenever possible (see, for example, Huber (1991) for vicarious learning) or labelled inductively based on the overall theme of the antecedent (Figure 2 provides a descriptive for each learning mechanism). Table II provides some representative data. Measures to ensure the trustworthiness of the qualitative data and the robustness of our analysis included using NVivo 9 to manage the process in a systematic and consistent manner and confirming the validity of the preliminary analysis with respondents to identify and correct any misunderstandings or omissions.

## 4. Findings

Our detailed investigation identifies six learning mechanisms that enhance SCRes. These learning mechanisms explain how decisions and actions of organisations intentionally and unintentionally facilitate the adaption of routines (linked to the formative resilience elements) in preparation for, response to and recovery from supply chain disruptions. We now introduce the six learning mechanisms identified and their antecedents in the three stages of a disruption. Specific examples of adapting operating routines for each of the six learning mechanisms can be found in Figure 2. For clarity, the presentation depicts a clear delineation between each phase, although in reality some overlaps occur.

### 4.1 Preparation mechanisms

As supply chain disruptions are non-routine events that vary depending on the particular context and circumstances (Pettit *et al.*, 2010), it is difficult to detail specific routines that may be required or prove useful prior to an occurrence (Levinthal and March, 1993). As such, learning mechanisms in advance of a supply chain disruption may be considered conceptual (Su and Chen, 2013) or experimental learning (Huber, 1991) as the impact of adapting operating routines on SCRes cannot be

**Table II** Coding excerpt

| Second-order categories | Representative data (first-order codes) | Third-order theme | Learning mechanisms |
|---|---|---|---|
| **Knowledge creation during preparedness** | "We do recognise the need to put in a few strategic warehouses around the world, whether one, two or three is not yet decided. I think we will probably align them regionally to be honest. I mean, we have operations now in Central and South America, we have operations in Africa and we have operations in Asia, so what I would foresee is having one somewhere in Central or South America, one somewhere in Africa, maybe Dubai or somewhere like that, and then one perhaps in Malaysia or Singapore to support Asia. . . . . ." (Interviewee A, Yellow) | Growth | Processual learning |
| | "In the past we have had the habit of promoting from within. So, we have the same set of cards on the table and we are inclined to move the cards about. I am sort of keen now in the supply chain planning department to stop moving the cards around and we start bringing new cards in – and those new cards should be graduate calibre" . (Interviewee A, Yellow) | Change in strategy | |
| | "I think we are looking at improving it by bringing in a much more comprehensive one [IT system]; this will give us total visibility, but also more integration, so that we can see the planning that has taken place at the country level and be able to project that and see that, you know, we know that Country X has planned to purchase this within a given year, how does that translate into our preparedness?." (Interviewee B, Purple) | Operational refinement | |
| **Knowledge transfer during preparedness** | "So, from the analysis from last year we defined four key areas: one was customer collaboration, one was introduction to supply chain management, one on change management and one on project management. So, we got everybody in the team to attend these lectures and then we assessed the lectures afterwards. We sent out questionnaires to see if people actually absorbed the information. So I think that illustrates how seriously we are taking it . . . We are also encouraging people to get APEX-qualified and I am doing a masters in supply chain management. We are trying to build capabilities within the team around what we deem to be key areas of the business." (Interviewee C, Green) | Training | Anticipative learning |
| | "People are very willing to give up information – they will give you, for example, their salary structure. Or, if we are developing a new policy, there is no point in reinventing the wheel if somebody somewhere has already done it. The same for ourselves, we have done quite a lot that others haven't, so there is a lot of information and knowledge sharing." (Interviewee A, Red) | Collaboration | |
| **Knowledge creation during response** | "I guess we had to learn, how to make do with what we had, with what we could give the customers at that moment. We also have to learn, even now you know, because changes are still happening. You know, we learned not to necessarily depend so much on systems, but you know, keep the independence from the system." (Interviewee C, Blue) | Disruption | Situational learning |
| **Knowledge transfer during response** | "Previous to that, in Afghanistan, different situation but similar impact, similar potential impact for beneficiaries in that we couldn't get food to them because the winter had set in. We were up in northeast Afghanistan where it really is all mountains, you couldn't get over them, you couldn't get vehicles over them, you couldn't get trucks up there, so we couldn't get the food in. We spoke to the local communities asking how, at this time of the year, they got over the mountains. So they said they used donkeys to transport everything. So for six weeks we hired 1000 donkeys and it was a one day trip, you could get over and back in a day with donkeys." (Interviewee C, Red) | Collaboration | Collaborative learning |
| **Knowledge creation during recovery** | "But also the only moment they can go through reflection to review things is in hindsight; you know, what they could have done differently given the same scenario." (Interviewee C, Green) | Review | Experiential learning |
| | "So there is much more communication between the organisations as a result of what has happened since 2006." (Interviewee H, Blue) | Experience | |
| **Knowledge transfer during recovery** | "I had one example where systems were developed for an emergency, for a large-scale emergency, and then they were discontinued; and then another large-scale emergency happened and they had to do it all over again. Then they leave it like this, and then a third one happens and they have to do it all over again, and it was literally frustrating to see that." (Interviewee A, Green) | Best practice | Vicarious learning |

**Figure 2** Specific examples or changes in routines per learning mechanism

| Learning Mechanism | Antecedent | Specific Example | Change in Routine | Source of Learning | SCRes Elements |
|---|---|---|---|---|---|
| **Processual Learning** *Knowledge creation based on inherent processes.* | *Growth* | Expansion to several new markets (Yellow) | Decentralisation: additional warehouses and representatives closer to the market | Internal | Flexibility Velocity |
| | | Start using an ERP system to extend information capacity and accuracy (Yellow) | Use system instead of e-mails and spreadsheets | | Visibility |
| | *Change in Strategy* | Focus on emerging markets (Purple) | Decentralisation: additional warehouses and customer services closer to the market | | Flexibility Velocity |
| | | New hiring policy (Purple) | Supply chain employees have to come from outside the company with supply chain degrees | | Robustness |
| | *Operational Refinement* | Establishing a repository of experiences (Red) | Share experiences throughout the organisation | | Visibility Collaboration |
| | | Using a new forecasting technique that identified new gaps (Blue) | Additional preparedness activities to close gaps | | Robustness |
| | | Development of a new integrated supply chain system (Green) | Visibility of the overall supply chain to everyone in the organisation, improving preparedness planning | | Visibility |
| | | Annual portfolio review (Purple) | Consolidation of low volume SKUs | | Robustness Velocity |
| **Anticipative Learning** *Knowledge transfer based on identified gaps.* | *Collaboration* | Sharing information on existing specific policies with other organisations (Red) | Use already existing knowledge | Cross- Industry/ Competitors | Collaboration Visibility |
| | | Collaboration with external parties other than NGOs, i.e. with governments, customs, ministry of foreign affairs, academics or private sector (Green) | - Improve existing supply chain processes<br>- Set up strategic partnerships | - Governments<br>- Academia<br>- Private sector organisations | Collaboration Visibility Robustness Flexibility Velocity |
| | | Sharing of information with customers, regular reviews (Purple) | Implementation of EDI and VMI with customers | Customers | Collaboration Visibility Flexibility |
| | *Training* | Training of staff through academia (Red, Green and Purple) | - Increase in functional engagement and participation of logistics and planning (Red)<br>- Review of network capacity rather than stockpiling (Green)<br>- Increase customer collaboration (Purple) | Academia | Collaboration Robustness Flexibility Visibility Velocity |
| **Situational Learning:** *Knowledge creation in the moment of disruption* | *Disruption* | Bidding against oneself with different freight forwarders (Red) | Established reliable and preferred freight forwarder | Internal | Collaboration Visibility |
| | | Wrong items for people in need (Blue) | Consider cultural and ethnic character of recipients | | Flexibility Velocity |
| | | Relocation of warehouse which led to not being able to serve customers as needed (Purple) | Bring people from old operation to new operation | | Visibility |
| **Collaborative Learning** *Knowledge transfer in the moment of disruption* | *Collaboration* | No access to people in need (Red) | Get input from locals on how to transport goods | Customers | Collaboration Flexibility Robustness |
| | | No access to country with emergency (Red) | Partner up with development-oriented organisation | Cross- Industry/ Competitors | Collaboration Robustness |
| | | Uneven damage, response and recovery across the region (Blue) | Set up a group to manage the availability of resources and knowledge. This group then became a permanent disaster preparedness group | Cross- Industry/ Competitors | Collaboration Visibility Flexibility Velocity |
| **Experiential Learning** *Knowledge creation based on the reflection of the experience* | *Review* | Review of recent events, e.g. emergency, with all functions involved | - Change in HR Policies (Red)<br>- Lessons learnt for improvements (Red, Green, Blue, Purple, Yellow)<br>- Implement beneficiary satisfaction survey (Blue) | Internal | Visibility Velocity Flexibility Robustness Collaboration |
| | *Experience* | Chaos in information sharing (Red) | Set up a focal contact point | | Visibility Velocity |
| | | Problems in getting parts delivered on time (Yellow) | Creation of back-up plans | | Flexibility Velocity |
| | | Shelter was also in danger of being flooded (Blue) | Shelters are at least 20 miles away from affected areas | | Robustness |
| **Vicarious Learning:** *Knowledge transfer based others' experiences and reflections* | *Best Practice* | No recognition of logistics in the field, late involvement of logistics Scapegoats (Red, Green) | Systematic logistics training of field offices (downstream) | Downstream supply chain | Robustness |
| | | Additional volume at third party logistics providers for which they did not have the required resources (Purple) | Weekly review with customers | Customers | Visibility Velocity |

anticipated. In our data, we find evidence of two types of learning mechanisms that foster SCRes during the preparation phase:

1 processual learning leading unintentionally to new operating routines; and
2 anticipative learning that, through formal training, education and collaboration, intentionally adapts routines.

### 4.1.1 Processual learning

Our study finds routines developing unintentionally as a result of the proactive creation of knowledge linked to reactions to changes in strategy, organisational growth and operational refinement, which we label as processual learning. We see that operational refinement in the form of a new integrated supply chain system (Green), new forecasting techniques (Blue) and the establishment of an annual portfolio review (Purple) creates knowledge that simplifies/re-organises the supply chain and improves the formative resilience elements of visibility, robustness, velocity and collaboration: "I think we are looking at improving it [IT system] by bringing in a much more comprehensive one; this will give us total visibility, but also more integration." (Interviewee C, Green). Reactions to changes in organisational strategy and growth over time lead to learning in preparation for a disruption. Reactions to internal changes (such as a supply chain extension in Yellow) and to uncontrollable external events (supply chain management industry standards in Purple) proactively built SCRes. Consistent with Ellis and Shpielberg (2003), we see that routines had to be altered for effective organisational adaption to such events as they could no longer be accommodated within existing knowledge. Hence, growth, operational refinement and changes in strategy increase the formative resilience elements of flexibility, visibility and velocity through exposure to new knowledge.

### 4.1.2 Anticipative learning

Our data further indicate that formal training and education, as well as collaboration, lead to proactive knowledge transfer. Conceptual learning focuses on understanding possible causes/solutions and cultivates knowledge that is not present in the current system (Su and Chen, 2013). We find that learning takes place intentionally in anticipation of possible disruptions with the aim of transferring knowledge from supply chain members or broader network stakeholders so that established routines can be improved or new ones created (e.g. for disaster preparedness, risk awareness, recognition of the importance of supply chain management and general supply chain management practices). This is achieved through specific staff training or by learning from supply chain partners, as well as in collaboration with other industries:

> If we are developing a new policy, there is no point in reinventing the wheel, if somebody somewhere has already done it. Same for ourselves, we have done quite a lot that others haven't, so there is a lot of information and knowledge sharing. (Interviewee A, Red).

Consistent with research conducted by Jüttner and Maklan (2011), we find that training and collaboration build SCRes as knowledge created in one part of the supply network or in another industry is spread and shared leading to an increase in the formative resilience elements of visibility, flexibility,

velocity, robustness or collaboration. A practical example of how to transfer knowledge proactively in practice was provided during observation of a preparedness meeting at Blue. Here, the established disaster preparedness plan was evaluated and refined based on the knowledge and resources available from all the network members. Hence, the transfer of knowledge about resources and capabilities available in the network allows to formulate contingency plans jointly, thereby encouraging and supporting continuous improvement (Hyland *et al.*, 2003) and fostering the formative SCRes elements of visibility and collaboration.

## 4.2 Response mechanisms

We find that learning that takes place during the response phase is *unintentional*, arising from the need to identify and develop a solution to enable supply chain operations to continue. This is either owing to insufficient time to allow a preparation phase between an anticipated disruption and its impact or because of the absence of a contingency plan (such as having a second supplier or redundant capacity), a finding which is consistent with the research of Christopher and Peck (2004). However, the essence of resilience is that disruptions cannot always be anticipated and, therefore, supply chains need to demonstrate an adaptive capability to respond and recover. The responsive learning mechanisms identified relate to the disruption itself: situational learning that creates knowledge and collaborative learning through knowledge transfer. Our findings suggest that both mechanisms create long-term memory and adapt operating routines to prevent the same disruption from recurring.

### 4.2.1 Situational learning

Our data indicate that knowledge creation can occur during the response phase if any of the supply chain flows ceases such that an immediate solution is necessary. This requires the modification or creation of routines to guide organisational behaviour (Levitt and March, 1988). We find evidence that situational learning frequently arises unintentionally when operational issues such as importation laws (Yellow), dealing with 3PLs (Red) or information systems (Blue) disrupt the supply chain. These disruptions allow the identification of gaps in organisational routines that possibly could have been anticipated, but were not, such as when market importation laws disrupted Yellow's operations in South America. As such, our findings indicate that the disruption itself is the antecedent to situational learning and linked to the resilience formative elements of flexibility, visibility, velocity or collaboration elements.

### 4.2.2 Collaborative learning

Similar to our findings on situational learning, the data indicate that knowledge transfer can take place during the response phase when an immediate solution is necessary because of the absence of a contingency plan or missing anticipation of the situation. Here, our data suggest that agility is of immense importance and triggers non-routine supply chain collaboration or knowledge transfer across parties in the supply chain and broader network that may not have formally shared knowledge before the disruption. Hence, the learning takes place unintentionally.

> We were up in northeast Afghanistan where it is really all mountains, you couldn't get over them, you couldn't get vehicles over them, you couldn't get trucks up there, so we couldn't get the food in. We spoke to the local communities [consumers] asking how, at this time of the year, they got over the mountains. So, they said they used donkeys to transport everything. So, for six weeks we hired a thousand donkeys and it was a one-day trip, you could get over and back in a day. (Interviewee C, Red).

The seven instances identified that link to this learning mechanism all relate to disruptions where the internal creation of knowledge did not render a solution. As such, external knowledge and resources from suppliers, consumers, competitors or broader stakeholders such as the government were required to address the disruption. Our findings indicate that realising the benefits of complementary knowledge resources in a network leads to collaborative learning while, at the same time, building new routines that create resilience to future disruptions through the formative resilience elements of flexibility, robustness, visibility, velocity and collaboration.

### 4.3 Recovery mechanisms

Organisations that learn from previous non-routine events decrease the likelihood that a similar disruption would have the same impact in the future (Madsen, 2009). Lessons are captured in new routines that improve skills and expand capabilities (Lampel *et al.*, 2009). Organisations use mechanisms that facilitate information interpretation, the exchange of views, attitudes and information as well as the transfer of knowledge to create new organisational knowledge and routines (Ellis and Shpielberg, 2003). This implies that learning mechanisms during the recovery phase *intentionally* build routines for SCRes. We identify that experiential learning happens based on knowledge creation and vicarious learning through knowledge transfer.

#### 4.3.1 Experiential learning

We find that significant learning takes place through the creation of knowledge in the recovery phase of a disruption. Rigorous and thorough learning from experience can lead to better decisions in the future, particularly in terms of internal adjustments to operating routines (Ellis and Shpielberg, 2003). Reflection on experiences or formal reviews are antecedents of experiential learning (Huber, 1991; Zollo and Winter, 2002) and build SCRes with the intention of limiting the impact of future disruptions. Here, the formative resilience elements of visibility, velocity, flexibility, robustness and collaboration can be improved. Our data indicate that some organisations intentionally formalise learning by holding reviews to limit the impact of future similar disruptions:

> We did an OND [October – November – December] review, quite a detailed report, you know, got input from everybody. We tried to identify what went well, what didn't go so well and what would you do differently. We came up with detailed recommendations on how we would change it and go forward this year. So I implemented this, and this year has gone quite well. (Interviewee B, Purple).

However, organisations need to be careful not to fall into the trap of retrospective simplification (Christianson *et al.*, 2009): learning from experience requires these experiences to be interpreted (Levinthal and March, 1993) not simplified. Our interviewees seemed to be aware of the value of reviews in avoiding similar mistakes. However, only three of the sampled organisations undertake regular reviews to not only assess errors but also evaluate what works well. This suggests an incomplete review

process elsewhere. Although our data do not allow us to identify the consequences of an incomplete review, the findings from the organisations that do assess what went well suggest that a failure to reflect on positive outcomes might inhibit organisations in seizing all the benefits of intentional experiential learning.

#### 4.3.2 Vicarious learning

In the case organisations studied, vicarious learning is based on trying to address the shortcomings in information sharing and collaboration that led to the disruption:

> So we now have a weekly meeting with them [the 3PL warehouse provider] in place, where we discuss the operation with them. So, yes, it is about having stronger relationships with them. It is about understanding their capabilities better. (Interviewee C, Purple).

This in turn increases the formative resilience elements of visibility, flexibility and robustness. When asking interviewees to recall specific disruptions, and how they learned from them to ensure that they never happen again, only three examples of knowledge transfer during the recovery phase were raised. This suggests that organisations make limited use of learning through transferring knowledge from similar events within the supply chain, in other industries or businesses after a disruption has taken place. While we find that organisations engage in collaborative learning when a solution has to be found in the face of a disruption, there appears to be no immediate need for vicarious learning. On the contrary, we find examples where no collective supply chain memory was built and the same disruption re-occurred: "The one thing I suppose that sticks out in my mind [...] it must be six, seven years ago, the time when we moved one of our warehouses from one supplier to another. [...] The one key thing is that it really boiled down to bringing some of the people that worked on the old operation to the new operation, it really was as simple as that." (Interviewee B, Purple) as against "Recently we changed warehouse contractor and it didn't work. [...] I don't think the handover between the two sites was as good as it could have been". (Interviewee C, Purple).

This comment highlights, how a disruption happened twice within the internal network of the multinational organisation as the learning experience of one business unit was not shared with that of the other. As such, vicarious learning did not take place.

In summary, we identify six learning mechanisms and their antecedents that can help to foster SCRes and lead to new operating routines during preparedness for, response to and recovery from disruption. While anticipative (during preparedness), experiential and vicarious (during recovery) learning are intentionally initiated by the organisations, we find that processual (during preparedness), situational and collaborative (during response) learning lead to unintentional learning effecting SCRes. In addition to these learning mechanisms, we also identify nine antecedents for the six learning mechanisms. These antecedents stimulate both the learning mechanisms and the formative resilience elements underpinning the adaptive capability of SCRes. Furthermore, for learning mechanisms related to knowledge transfer, i.e. anticipative, collaborative and vicarious learning, our data show a large variety of learning sources across the internal supply chain (as interviews were taken from headquarters) and the broader supply network including learning between the organisations and in country offices, suppliers, customers,

governments, competitors, academia and organisations that can be considered supply chain leaders. Drawing on established theoretical relationships between learning, dynamic capabilities and the evolution of operating routines (Zollo and Winter, 2002), and abstracting from the findings summarised in Figure 2, Figure 3 depicts our elaborated conceptual framework including the identified intentional and unintentional learning mechanisms fostering SCRes and the specific antecedents of these learning mechanisms.

## 5. Discussion

### 5.1 Theoretical implications

The development of this elaborated model SCRes learning provides two important theoretical contributions. First, while previous research establishes that learning mechanisms for SCRes include learning from previous experiences (experiential learning) and through training (anticipative learning) (Chowdhury and Quaddas, 2016), our findings advance theory by explicating four additional learning mechanisms for SCRes: processual learning, situational learning, collaborative learning and vicarious learning. The broader literature provides a general understanding of learning mechanisms (e.g., Pisano, 1994; Huber, 1991), but does not identify how such mechanisms relate to the adaptive capability of SCRes. We not only open the black box of how learning builds the adaptive capability of SCRes by identifying learning mechanisms and their antecedents, but also show that learning happens during all three disruption phases (preparation, responds and recovery). While previous literature often considers learning as a separate fourth phase that follows recovery (e.g., Hohenstein *et al.*, 2015), we find that learning is ongoing across all stages of a disruption. For instance, the examples in our data vividly demonstrate that learning associated with responding rapidly to a disruption can lead organisations to adapt their routines immediately rather than after recovery. Accordingly we propose:

*P1.* Different types of learning mechanisms contribute to the adaptive capability of SCRes during all three phases of disruption (preparation, response and recovery).

Our second contribution is to reveal the value of unintentional learning for SCRes. Theory development to date has largely centred on intentional learning (e.g., Hora and Klassen, 2013) and, in spite of its implicit importance, unintentional learning has been largely overlooked. In addressing this oversight, we expose and analyse unintentional learning in practice. We find that while anticipative, situational and vicarious learning *intentionally* enable

**Figure 3** Elaborated model of SCRes learning (antecedents and mechanisms)
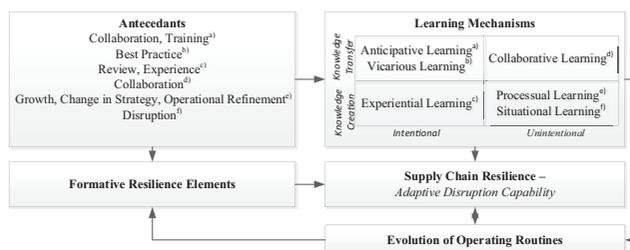


the creation/adaption of operating routines to prepare for or recover from a disruption and/or to build SCRes, processual, collaborative and experiential learning enable the *unintentional* adaptation of routines in preparation for and in response to supply chain disruptions. Accordingly we propose:

*P2a.* Organisations and their supply chains intentionally increase SCRes through anticipative, situational and vicarious learning mechanisms.

*P2b.* Organisations and their supply chains unintentionally increase SCRes through processual, collaborative and experiential learning mechanisms.

Furthermore, by revealing the antecedents of learning for SCRes, we add to our understanding of how unintentional learning can become intentional. Inherent in previous work is the notion that intentional learning in organisations requires an explicit aim if the causalities and linkages between practices and performance are to be understood (Berghman *et al.*, 2013). This argument suggests that the potential to learn may be lost in the absence of an explicit intention to learn (Ghoshal, 1987). However, theorising from our findings suggests that the antecedents of unintentional learning may facilitate organisations in transforming such unintentional learning into a more conscious, explicit endeavour to build their SCRes' adaptive capability. Accordingly we propose:

*P2c.* Awareness of the antecedents of unintentional learning allows organisations and their supply chains to transform unintentional learning into explicit learning.

Further, our findings provide some insight into inter-organisational learning, an aspect that has been shown to facilitate SCRes (Manuj and Mentzer, 2008) and more broadly enhance the competitive advantage of a supply chain as a whole (Bessant *et al.*, 2003; Cheng *et al.*, 2008). On the one hand we find that learning happens not only across the supply chain with customers and suppliers but also within the broader network of stakeholders, including competitors, governments and academia. In our cases, organisations Red, Green and Blue actively transfer knowledge within the same sector, for example, by sharing their existing policies. Such learning across a network of industry partners has attracted considerable attention, particularly in relation to improving sustainability, (e.g., Oelze *et al.*, 2016) and organisations are quick to recognise the value of inter-organisational learning. On the other hand, however, we also find that learning through knowledge transfer is rather limited in the re-active phase of a disruption i.e. response and recovery. We reveal that when preparing for disruptions, organisations actively seek knowledge externally, but when dealing with disruptions, organisations prefer to look inside and rely on internal knowledge. One explanation for this might be that disruptions often attract negative press, threaten reputations and bring the need to find a scapegoat so organisations prefer to constrain their exposure in house. As a result, the potential to learn from the knowledge of others is lost, which may lead to the same disruption happening repeatedly within the supply chain. As this may lead to possibly avoidable losses, organisations may need to find better ways of transferring knowledge within the

supply chain and broader network, whether that is done explicitly or more implicitly for safeguarding.

## 5.2 Managerial implications

Although many managers are aware of the dangers of supply chain disruption and the value of SCRes, they may be less familiar with the role of learning in unlocking the potential to create new routines or adapt existing routines for SCRes. This study provides several valuable insights to address this urgent and widespread practitioner requirement (Jüttner, 2005; Ponomarov and Holcomb, 2009). We show how the impact of a supply chain disruption may be reduced by learning in all three disruption phases. Furthermore, being aware of the antecedents of unintentional learning may allow managers to support greater employee engagement in these activities.

More specifically, our work reveals the potential value of giving greater attention to knowledge transfer, particularly in relation to collaborative and vicarious learning across the supply chain and broader network of stakeholders not only in preparation for, but also in response to and recovery from disruptions. This is especially relevant as any learning in preparation for an event is largely experiential, such that the relevance of the learning is unknown before the event. However, particularly vicarious learning, by drawing on the experiences of others, brings greater certainty that the insights gained will lead to greater SCRes. Organisations should regularly review both their negative and positive supply chain experiences while benchmarking against best practices in other supply chains or firms where a similar disruption has occurred. Such analysis requires managers to step back from their day-to-day operations and consider processes and activities beyond their own function to create a holistic view of the supply chain. Accordingly, we recommend that managers pay more attention to vicarious learning strategies when investing resources in building SCRes.

Given the established positive association between collaborative supply chain activities and SCRes (Scholten and Schilder, 2015), we were initially surprised by the few examples of inter-organisational learning in our data, but further reflection revealed two possible implications for managers from this finding. First, an appropriate organisational risk management culture may be required if inter-organisational learning via the transfer of knowledge is to be promoted. Some of our case organisations did not evidence a strong risk-management culture, and overall the cases exhibited weak strategic focus and commitment to the concept of supply chain management. This prompts us to suggest that managers must firmly intend to create and transfer knowledge of disruptions or much of the potential to foster SCRes may be lost. Second, we are aware that transferring knowledge gained from a disruption may include sensitive information unsuitable for sharing with all supply chain partners or even the broader network. As such, we would recommend that managers should initially exchange knowledge with supply chain partners they know and trust and then extend collaborative and vicarious learning across the broader supply network.

## 6. Conclusions

In spite of the implicit understanding that learning is a fundamental property of SCRes adaptive capability (e.g., Ponomarov and Holcomb, 2009), prior literature fails to clarify how organisations can adapt their operating routines to deal with supply chain disruptions. Putting the concept of non-routine events centre stage and drawing on the conceptual framework of learning originally proposed by Zollo and Winter (2002), this study develops an elaborated model of SCRes learning. In particular, we identify six learning mechanisms and their antecedents for building SCRes, thereby explaining how operating routines are adapted through knowledge creation and/or knowledge transfer. Furthermore, by highlighting not only intentional learning but also antecedents of unintentional learning, this study provides new fine-grained details that allow learning to be a more intentional endeavour so that SCRes can be improved through all three phases of a disruption.

This study has limitations that provide avenues for future research. As with much case research, we purposefully selected a few cases for in-depth exploration. Given the limited number of organisations studied, generalising our findings more broadly is questionable. However, as with Jüttner and Maklan (2011) and Scholten *et al.* (2014), our aim was to develop theoretical concepts and not to generalise to populations or universes, and so our emphasis was on analytical rather than statistical generalisation. As such, the findings of this study may spark new discussions on the learning aspects of SCRes in both theory and practice. Throughout our data analysis, we were very careful to observe trustworthiness criteria for qualitative research to increase the transferability of our results. However, the first coding criterion in the data analysis was an observable behavioural change in line with definitions of learning. As learning does not always lead to observable changes in behaviour (Huber, 1991), we may have missed instances of learning in our data. In addition, while the potential creation or loss of knowledge through staff turnover was outside the boundaries of our study, future research could investigate the potential for organisational "unlearning" through employees leaving the organisation and its impact on SCRes.

A disruption can lead to negative financial effects, business closures and, in worst-case scenarios, to death, or it can be an opportunity for success leading not just to supply chain recovery but also to improved functioning. Given this range of outcomes, future research could adopt a performance outcome view of learning for SCRes to explore how learning mechanisms could help a supply chain recover to an enhanced state of functioning after a disruption. We found that recovering successfully from a disruption involves learning from experience to boost future preparedness and protection (Ponomarov and Holcomb, 2009) and ensure that organisations learn from the past mistakes of both themselves and others.

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