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DYNAMIC CAPABILITIES IN SUPPLY CHAIN RESILIENCE MANAGEMENT IN THE FINNISH ENERGY INDUSTRY

Abstract: *Over the last two years, industrial companies have faced unexpected global crises whilst simultaneously they are going through a transformation process with the aim of increasing renewable energy usage. To maintain competitiveness in a changing business environment, dynamic capabilities are needed in supply chain resilience (SCRes) management to proactively identify threats, respond agilely and implement change. This study aimed to identify what kinds of dynamic capabilities and microfoundations are needed in SCRes management in the energy industry. The research was conducted at Finnish energy industry companies. Research data from 19 semi-structured interviews were analysed according to the analysis framework of sensing, learning, integrating and coordinating. Eight microfoundations in the energy industry were identified. From those network collaboration, open communication and knowledge sharing, systematic supplier relationship management (SRM) and leadership were identified as key microfoundations for dynamic capabilities that affect sensing, learning, integrating and coordinating.*

Keywords: *Supply chain resilience, dynamic capability, energy industry*

1. Introduction

Industrial supply chains in Europe have faced unprecedented challenges with the ongoing COVID-19 pandemic (Ozdemir et al. 2022). Simultaneously with the COVID-19, also the general trend towards sustainable energy usage has increased the need to create resilient supply chains (Chrisandina et al., 2022). Many companies have faced disruptions in their supply chains (SC) and in their critical infrastructures (CIs). For instance, in the energy industry, disruptions have had large impacts on SC (Scholten et al., 2020; van den Adel et al., 2022).

Disruptions affecting the supply chain performance may be minimised by organizations' proactive preparedness and ability to react to different disruptions (Scholten et al., 2020). There is a need to build this capability through supply chain resilience (SCRes) (Kiers et al., 2022; Ozdemir et al., 2022).

Energy industry companies, which are of interest in this study, are continuously vulnerable to disruptions. Hence, they have to be able to maintain and build their SCRes in changing situations (Emenike & Falcone, 2020). The energy industry plays a critical role in our daily lives, and disruptions in SCs may have a significant impact on a variety of stakeholders. Thus, energy security needs to

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be ensured by improving SCRes (Emenike & Falcone, 2020; Urciuoli et al., 2014).

SCRes is a company's ability to tolerate, recover and adapt from disruptions (Jesse et al., 2019) but also to identify potential problems and monitor, respond to and learn from problems (Bento et al., 2021). SCRes needs to be built by various capabilities at different levels of organizations through the SC (Scholten et al., 2020; Bento et al., 2021). The need for organizational resilience (OR) is evident in this context. OR relates to organization's ability to tolerate disruptions and recover from them quickly by adapting needed resources, behaviours and capabilities that promote learning (Hillmann & Guenther, 2021).

Organizations' capabilities to learn, promote organizational leadership and build trust with internal and external stakeholders are important for gaining long-term development and survival capabilities (Do et al., 2022; Khan et al., 2019). Gained knowledge from crises, management practices, unified strategic vision, defined roles and information sharing with internal and external stakeholders enable process adaptation and promote innovativeness and OR (Bento et al., 2021; Khan et al., 2019).

In continuously evolving business environments, companies need dynamic capabilities to identify different risks that threaten their business and to respond to changes to build sustainable and innovative forms of competitive advantage in the long run (Teece et al., 1997, 2020). Dynamic capabilities describe companies' ability to create, build, reconfigure and transform organizational skills, competences and resources internally and externally and to build resilience in response to identified threats (Parker & Ameen, 2018; Teece et al., 1997). Dynamic capabilities can be described through OR (Kamalahmadi et al. 2016). High-order dynamic capabilities, microfoundations and ordinary capabilities form the structure of dynamic capabilities (Teece, 2007, 2018).

Interorganizational information exchange, competent employees, strategies and process design have earlier been identified as critical elements, i.e. the microfoundations for increasing, SCRes in the energy industry (Chrisandina et al., 2022; Liang et al., 2022; van den Adel et al., 2022). Standardized energy management systems promote sustainability in SC and organization's competitiveness (Zimon et al., 2021).

1.1 Research objectives

Recently, researchers have shown an increased interest in SCRes which has been discussed for instance concerning networking (Piya et al., 2022) and supplier involvement (Wieteska & Staniec, 2022 forthcoming). However, we have identified relatively few studies focusing on SCRes in the energy industry (Chrisandina et al., 2022; Emenike & Falcone, 2020; Piya et al., 2022; Zimon et al., 2022; Urciuoli et al., 2014), despite the topic's importance highlighted above.

In the energy industry, learning and new knowledge creation are identified as important capabilities contributing to resilience (Bento et al., 2021), yet a need for further research has been identified concerning the critical dynamic capabilities and sub-capabilities in different phases of sensing, seizing and transforming when implementing changes (Leemann & Kanbach, 2022). Further, the dynamics of adaptive processes in the energy industry and the interaction in learning and adaptation at different organizational levels and processes should be studied more profound to understand OR (Bento et al., 2021). In the energy industry, there is a need for research how interaction between different stakeholders effects to SCRes (Chrisandina et al., 2022).

To meet these research challenges and gaps presented above, this study aims to increase the understanding of the dynamic capabilities needed for SCRes management

in the energy industry and identify key microfoundations for SCRes. Special attention is paid to the identified microfoundations that influence how high-order dynamic capabilities are built in practice. To support the aim of the study, the following research questions were posed:

RQ 1. What kinds of microfoundations for high-order dynamic capabilities can be identified in SCRes management in the energy industry?

RQ 2. Which of those can be considered as the key microfoundations for SCRes in the energy industry?

The study was conducted as qualitative research, including a literature review and semi-structured interviews within the Finnish energy industry. The article is structured as follows: The background of the study, research objectives and research questions are described in Section one. Foundations for the theory of dynamic capabilities are provided in Section 2. Section 3 presents the research context, research data and methods for material collection and analysis. The results are presented in Section 4, discussed in Section 5 and the conclusion is summarised in Section 6.

2. Literature Review

The literature review provides a review of the dynamic capabilities framework and defines its content at different levels, from high-order dynamic capabilities and microfoundations to low-order capabilities. The literature review is summarised in Section 2.3 by Figure 1, which defines the content and interaction of different levels of dynamic capabilities. This figure is used as a base for presenting results, discussion and conclusions from empirical research.

2.1 Resource-based View and Dynamic Capability View

The resource-based view (RBV) of the company argues that competitive advantage can be created based only on the internal capabilities and resources available in an organization (Baškarada & Koronios, 2017; Eisenhardt & Martin, 2000; Peteraf, 1993). The RBV is based on the understanding that competitive advantage is achieved by developing and using internal strengths (Barney, 1991; Wernerfelt, 1984). The RBV highlights strategic management when creating competitive advantage (Eisenhardt & Martin, 2000). It has been argued that RBV is not sufficient to build competitive advantage and explain an organization's capability to adapt in a fast-changing business environment (Teece et al., 1997). In response, it has been proposed that dynamic capabilities are needed for reconfiguring internal and external resources and competences (Baškarada & Koronios, 2017; Eisenhardt & Martin, 2000; Peteraf, 1993).

The dynamic capabilities view explains organizations' abilities to respond quickly to changes in the environment by integrating, building, adapting and reconfiguring internal and external resources, competences, organizational skills and capabilities through microfoundations (Baškarada & Koronios, 2017; Teece et al., 1997). Dynamic capabilities are defined as homogenous, fungible and substitutable capabilities that are part of the existing knowledge and can be developed in different ways in an organization (Eisenhardt & Martin, 2000).

The dynamic capabilities framework includes the processes of sensing, seizing and transforming to maintain and develop competitiveness (Teece, 2007). Sensing in the context of dynamic capabilities means the capability to identify internal and external threats by learning about and observing the environment (Leemann & Kanbach, 2022). Identified threats are immediately responded to in the seizing phases and more generally responded to in

the transforming phase (Schoemaker et al., 2018; Teece, 2007). The transforming phase describes a capability to improve, combine and reconfigure organizations' tangible and intangible assets with resources and structures to reach a competitive advantage (Schoemaker et al., 2018; Teece, 2007).

Scientific discussion on the theory of dynamic capabilities is lively. For instance, Baškarada and Koronios (2017) have suggested supplementing a framework with sensing, searching, seizing, shifting and shaping to build organizational agility and continuous adaptation. Searching describes new internal opportunity creation in an organization, shifting describes implementing new strategies and shaping describes finding new capabilities (Baškarada & Koronios, 2017). In this study, the focus is on the theory by Teece et al. (1997), which is arguably the most prominent theoretical approach to the dynamic capabilities (Schreyögg & Kliesch-Eberl, 2007).

Strong dynamic capabilities require the ability to continuously transform an organization and culture while enabling sensing and seizing threats and fast resource alignment (Teece, 2018). It is important to identify and select critical capabilities to achieve competitive advantage but also to define how the capabilities can be improved and used (Linden & Teece, 2018).

Companies seeking for competitive advantage should have an interactive organizational culture based on processes, organizational structures, routines, skills, decisions, rules and incentives with long-term strategies (Bojesson & Fundin, 2020; Leemann & Kanbach, 2022; Teece, 2007). An aligned internal organizational structure enables resource modification, exploitation and expansion due to partnerships (Leemann & Kanbach, 2022; Wilden et al., 2013). It is important to identify key value-adding resources in the future to be able to create, extend and modify them and advance transformation using co-specialised internal

and external resources (Leemann & Kanbach, 2022).

2.2 High-order Dynamic Capabilities and Microfoundations

Dynamic capabilities consist of high-order capabilities and microfoundations that are both at higher level compared to routine, operational and low-order capabilities implementing business activities (Teece, 2007, 2018). High-order dynamic capabilities enable management to sense, seize and transform organizations and manage microfoundations so that the organizations can respond to future crises and changes in the environment (Teece, 2018). Microfoundations are second-order dynamic capabilities that adjust, combine and develop ordinary capabilities through the coordination and orchestration of internal and external resources with stakeholders (Teece, 2018). Processes and routines, such as quality control or performance measurement routines, are microfoundations for dynamic capabilities (Eisenhardt & Martin, 2000; Teece, 2011). Lower-order capabilities include physical, financial, organizational and human resources, which all create a base for dynamic capabilities and the RBV (Brusset & Teller, 2017).

Proposed by Pavlou et al. (2011), the identified high-order capabilities are sensing, learning, integrating and coordinating, which are highlighted as key capabilities to transform operational/low-order capabilities and respond to changes in the business environment (Pavlou et al., 2011).

Sensing is described as the capability to observe threats and opportunities in the environment as early as possible (Pavlou et al., 2011; Teece et al., 2020). Sensing occurs through collecting information from different sources and sharing it with various stakeholders, supported by organizational structures and processes to promote information flow (Teece et al., 2020).

Learning is a dynamic capability that involves the use of new knowledge to renew operational capabilities (Pavlou et al., 2011). Learning occurs by identifying external know-how, exchanging knowledge in interactions with internal and external stakeholders and agile decision-making (Pundziene et al., 2022; Teece, 2020). Collaboration between different organizational functions, organizational idea generation, learning from previous experiences, collecting information from employees and sharing new information enables expertise combinations and transformation (Bojesson & Fundin, 2020; Leemann & Kanbach, 2022). Employee engagement, organizational renewal through experimental learning and continuous environmental monitoring lead to strong dynamic capabilities and empowerment. (Pundziene et al., 2022). Continuous learning from experienced disruptions in collaboration with stakeholders enables the improvement of SCRes in the energy industry. (Chrisandina et al., 2022).

Integrating capabilities occur by combining knowledge from individuals to create new operational capabilities (Pavlou et al., 2011). Integrating is a dynamic capability that enables new capability development and skill combinations (Teece, 2016). Integration with internal and external stakeholders, vertically and horizontally, promotes information sharing and knowledge integration (Leemann & Kanbach, 2022; Teece, 2007). In energy SCs, integration has a positive impact on SCRes, as data integration and stakeholder collaboration increase risk visibility in SCs and SCRes (Chrisandina et al., 2022). Involved interorganizational networking through information exchange and communication between different organizations enables faster response to disruptions with less impact and increase resilience in critical infrastructures (CIs) field-like energy production (van den Adel et al., 2022). In the energy industry, collaboration, information sharing, trust and visibility increase agility

and build SCRes (Piya et al., 2022)

Coordinating capabilities are needed to orchestrate and reconfigure operational capabilities (Pavlou et al., 2011). The ongoing transformation in energy industry SCs towards sustainable energy usage requires resilience to withstand against disruptions by creating strategies and designing processes (Chrisandina et al., 2022). In production context, strategy has an impact on collaboration in organization and thereby on resilience (Dittfeld et al., 2022). Systematic organizing and entrepreneurial management cultures that promote innovativeness, creativity and sensing capabilities are important dynamic capabilities that improve risk mitigation and competitiveness building and need to be coordinated throughout the organization (Linden & Teece, 2018; Teece, 2016). Managers' leadership skills are an important dynamic capability required to create organizational culture and loyalty and to define a vision (Teece, 2016).

Proposed by van den Adel et al. (2022), managers need to create conditions to information exchange within the network of organizations. Committed, dedicated management and employees, a positive atmosphere in an organization, collaboration with different functions, business culture and clearly communicated targets and visions enable transformation (Bojesson & Fundin, 2020; Leemann & Kanbach, 2022). An organic organizational structure with good management competences, decentralised decision-making and the capability to identify risks and renew resources build dynamic capabilities (Teece, 2007; Wilden et al., 2013).

The previous research has established that competent workforce and human resources play a critical role in ensuring the ability to fulfill the increasing need for solar energy (Liang et al., 2022). It is important to enable agile decision-making throughout the whole process (Leemann & Kanbach, 2022; Teece, 2020). Proposed by Teece (2007), a culture

that enables sensing and seizing is built in collaboration with stakeholders and is defined as an entrepreneurial culture (Teece, 2007). It has previously been observed that standardized management systems such as ISO 50001 improve supply chain management by improving sustainability, competitiveness and stakeholder collaboration (Zimon et al., 2022).

2.3 Summary

High-order dynamic capabilities are accelerators for building dynamic capability multilaterally in SCs and organizations (Figure 1). High-order capabilities include sensing, learning, integrating and coordinating, which ensure the continuous circle of learning. They accelerate sensing, seizing and transforming processes through microfoundations and lower-order capabilities. Sensing, seizing and transforming are realised by microfoundations that must be managed to adjust low-order capabilities. At the same time, high-order dynamic capabilities are built by microfoundations and low-order capabilities, which indicate the importance of multilateral processes. As a result of these processes, organizations and supply chains build their dynamic capability and strengthen continuous learning, SCRes and long-term competitiveness.

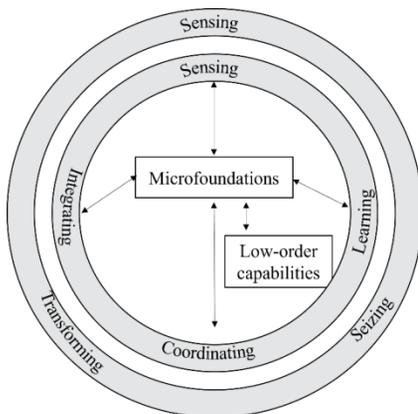


Figure 1. Dynamic capabilities structure and interaction

3. Materials and Methods

This qualitative research followed an inductive approach, using semi-structured interviews (Figure 2) (Kallio et al., 2016). A semi-structured interview guide was formed based on a literature review of SCRes and dynamic capabilities. A semi-structured interview is an interactive method (Galletta, 2012) aimed at providing a greater understanding of the dynamic capabilities needed for SCRes in the energy industry.

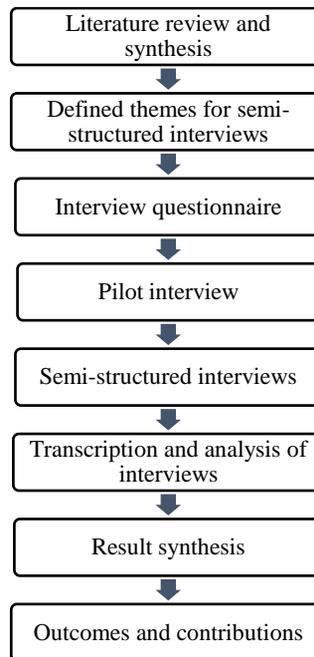


Figure 2. Research process

3.1 Data Collection

Following the principles of purposive sampling for company selection (Flick, 2007), the interviews were conducted with representatives of five energy companies and at the National Emergency Supply Agency (NESA). These six organizations constitute the research environment of this study and are among the largest energy companies in Finland, with revenue ranging from 100 million to 1 billion euros. The energy companies belong to a national industry

collaboration network, called the HSEQ® cluster (Jounila et al., 2020). The abbreviation HSEQ comes from the integrative management system approach (Kauppila et al., 2015; Wilkinson & Dale, 1999) that aims to integrate health, safety, environment and quality management under one management system. The cluster, including major energy and process companies in Finland, has developed and standardised its practices and processes for supplier HSEQ management for around 15 years (Kauppila et al., 2020).

Empirical data collection was conducted by the corresponding author through company-

specific group and individual interviews. Supply chain professionals representing different positions and units were the participants in this study (Table 1). In the semi-structured interviews, questions regarding the supply chain, personnel, continuity, risk, asset, safety, procurement, supplier and stakeholder management were asked. See Appendices 1 and 2 for the interview forms. Before the interviews, a pilot interview was conducted. Based on the pilot interview, minor modifications were made to the interview guide. All interviews were recorded and transcribed for analysis.

Table 1. Interviewees

Company	Interview participants	Number of interviews	Duration of interviews	Min and max duration of interviews
Pilot Company	Security, Risk and Quality Adviser	1 individual interview	1 h 14 min	1h 14 min
Company A	Production Manager Senior VP, Operations and Asset Management VP Sourcing and Purchasing Head of Unit Maintenance Chief Security Officer	5 individual interviews	6 h 51 min	56 min–1 h 52 min
Company B	Operations and Maintenance Manager Operations Manager Safety and Quality Manager HSEQ Manager IT Security Manager Sourcing Manager Maintenance Manager	3 group interviews, 1 individual interview	7 h 28 min	64 min–2 h 55 min
Company C	Environmental and Safety Specialist Manager, Production and Asset Management Operations Manager Managing Director	1 group interview	1 h 35 min	1 h 35 min
Company D	Purchasing Manager Operations Manager Maintenance Manager Safety and Security Manager	4 individual interviews	5 h 36 min	58 min–1 h 39 min
Company E	Supplier Development Manager Project Procurement Manager	3 individual interviews	4 h 6 min	42 min–1 h 55 min
National Emergency Security Agency	Power Systems Agent, Energy Supply Department	1 individual interview	1 h 4 min	1 h 4 min

3.2 Data Analysis

The first step of the data analysis process (Figure 3) was based on inductive reasoning utilising the theory of dynamic capabilities as presented by Teece et al. (1997) and SCRes and the energy industry as the analysis framework. Accordingly, the analyses started with research data analysis to identify microfoundations in the energy industry and categorise them according to sensing, learning, integrating and coordinating. Microfoundations for high-order dynamic capabilities in SCRes management were identified in the Finnish energy industry. Finally, the key microfoundations for high-order dynamic capabilities for SCRes in the energy industry were determined.

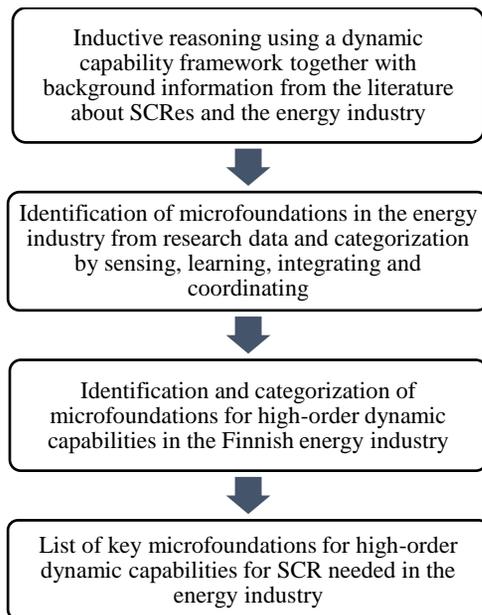


Figure 3. Data analysis process

4. Results

The identified microfoundations in SCRes management in the energy industry in Finland are described in subsections 4.1–4.4 and synthesised in subsection 4.5.

4.1 Sensing

Collaboration with internal and external stakeholders, for instance, other industrial companies, suppliers, the HSEQ® cluster and NESAs was highlighted in the interviews to promote sensing. The importance of mutual trust and open discussions was identified. Common proactive risk and business continuity management activities by stakeholders included information and knowledge sharing, joint workshops, risk reviews, proactive observations, site visits, documented business continuity plans (BCP), interactive feedback, open discussions and visibility to suppliers' processes and future needs. As indicated by Interviewee 4:

‘We should have the knowledge of the risk factors in the acquisition and also during the lifecycle of the contract. We need to have systematic but open dialogue with the supplier so that those potential risks can become visible. We should also have some kind of incentive model that would openly work and so they would have a desire to raise the development issues.’ (Interviewee 4)

Systematic supplier relationship management (SRM) with management models, supplier evaluations, incentives, audits and development discussions were highlighted by several interviewees. Performance monitoring by continuous supplier conditions follow-up, assessments and performance measurement were found important, for instance, using enterprise resource planning (ERP) and SRM systems to collect performance data and notify management of threats.

A common view of the interviewees was importance of identifying competence-related threats by defining the available competences and competence needs for the future. It was suggested that leadership has an effect, through commitment and empowerment, on how actively employees

identify threats, as proposed by Interviewee 3:

‘Threats identification and actions are everyone’s responsibility.’ (Interviewee 3).

4.2 Learning

On the whole, the participants demonstrated the importance of knowledge sharing and interactive communication between buyers and supplier companies as elements for learning. It was suggested that learning is built by creating visibility to the whole supply chain to identify future changes, critical business needs and different requirements, such as legal requirements, imposed on various stakeholders in SC. The majority of participants agreed that proactive business continuity management (BCM), BCPs, proactive observations, risk reviews, site visits, observation rounds, documentation and corrective and preventive action planning were important to improve responses to identified threats. A common view identified in the interviews was that participation in the HSEQ® cluster increases peer learning. NESAs pools that developed business continuity and security of supply were identified by some interviewees in order to share knowledge with other stakeholders in the same industrial field and to discuss solutions to respond to threats. It was emphasised that continuous feedback, joint workshops, brainstorming, development discussions, supplier evaluations, audits and open discussions about risks and preparedness are needed, as Interviewee 25 pointed out:

‘Employee eagerness for development is a lifeline and you can’t resist development. Participation in development is not restricted from anyone. Earlier it was just customers and suppliers participating in development, now there are third and fourth parties and everyone’s competence is utilised to create

something bigger and beautiful together.’ (Interviewee 25)

Continuous performance monitoring and assessment were a common factor indicated in the interviews. It was highlighted that supplier conditions need to be continuously monitored at different organizational levels by following up on failure rates, making visual observations, measuring performance and implementing assessments and corrective actions. SRM and ERP system data availability, system integration and SRM tool accessibility for suppliers were common factors that interviewees indicated were important. It was seen as important to use the available data to measure, follow and manage performance when responding and transforming.

The majority of participants indicated that competence identification and development, for instance, by mentoring and increasing cross-competence, was seen as important. It was seen as important to identify available competences using a competence map of the current state for future supplier plans and competence development, training and education in collaboration with the supply network.

4.3 Integrating

A common view of interviewees was that continuous collaboration builds stakeholder integration with internal and external stakeholders, suppliers, the HSEQ® cluster, NESAs and other industrial companies. It was suggested that common training and proactive planning with other industrial companies and stakeholders is important, as proposed by Interviewee 4:

‘If we think about it generally, we can implement this change to category management so that the business units are joined. Internal integration is in a key position so that this can succeed.’ (Interviewee 4).

Interactive supplier collaboration to promote responsiveness and transformation was a

common factor that was seen as important by interviewees as were proactive interactions with critical suppliers, common proactive planning, common meetings, management plans and training. Defined competence needs and competence maintenance and development, in close interaction with supplier networks, were highlighted by several suppliers. Proactive interaction is supported by the category sourcing model to achieve partnership. The interviewees on the whole demonstrated the importance of open and trust-based collaboration with open discussion, information sharing and dialogue in interaction, as Interviewee 4 pointed out:

‘Inclusion of suppliers to build common good is the thing. The management of external resources could promote improvements. We need to create an atmosphere in which we have openness, trust and dialogue.’ (Interviewee 4).

Systematic SRM was highlighted by several interviewees. The implementation of the category sourcing model, common workshops, proactive planning, partnership building and development discussions with suppliers were found to be important. Only a small number of respondents indicated the importance of early supplier involvement.

4.4 Coordinating

A common view raised in the interviews was that empowerment and a committed leadership culture are needed, from top management to the operational level, to coordinate people. The majority of participants agreed with the statement that internal and external supplier’s employees need to be involved in strategy work, employee opinions need to be considered and employees should be given responsibility for implementing development activities based on strategies. Joint development days of the company and employee surveys were seen as important tools for empowering employees, as proposed by Interviewee 14:

‘In our company, we have open and visible strategy implementation and action plan building where everyone had an opportunity to produce contents.’ (Interviewee 14).

It has been suggested that defined management structures need to be coordinated and orchestrated by management. A common view raised in the interviews was that management needs to define priorities for critical products and services and identify critical suppliers to commit to them. Participants on the whole demonstrated a need to define targets, roles, responsibilities, key tasks and competences for the current state and the future. For supplier management, systematic management methods, common targets and sourcing strategy were highlighted. All interviewees argued that standardised processes with defined steps, process charts and instructions increase systematicity. A common view amongst interviewees was that a BCM structure is needed in the whole SC, including proactively prepared BCPs with action, mitigation and recovery plans, management models, defined management groups and crisis communications models. The participants on the whole demonstrated that it is essential to require BCPs from critical suppliers and to implement practical training and simulations in collaboration with buyer and supplier companies.

A common view expressed in the interviews was that communication and information flow between stakeholders needed to be coordinated. It was suggested that regular risk management should be part of decision-making to ensure appropriate information flow to decision-makers in supplier and buyer companies. Several interviewees argued for the importance of mutual long-term planning with stakeholders. The participants on the whole demonstrated the need for defined roles and responsibilities, resource planning and understanding of the connections and dependencies of critical products and services.

4.5 Results Synthesis

As shown in Table 2 eight key microfoundations for developing dynamic capabilities for SCRes in the energy industry were identified. Four of those dynamic capabilities — network collaboration, open

communication and knowledge sharing, systematic SRM and leadership—were identified as microfoundations affecting all four high-order capabilities: sensing, learning, integrating and coordinating.

Table 2. Key microfoundations for high-order dynamic capabilities in SCRes management in the Finnish energy industry.

Microfoundations	Description
Collaboration with stakeholders (sensing, learning, integrating, coordinating)	Collaboration with stakeholders is realised with internal and external stakeholders. It is realised by common proactive risk and business continuity management, corrective action planning, competence planning and development, open discussions and mutual long-term planning. Collaboration with NESAs and HSEQ® cluster is important.
Communication and knowledge sharing (sensing, learning, integrating, coordinating)	Communication and knowledge sharing are realised through visibility and interactivity, open discussions, providing feedback, common brainstorming, and sharing information and knowledge with internal and external stakeholders. Participation in the HSEQ® cluster and NESAs pools improves information and knowledge sharing.
Systematic SRM (sensing, learning, integrating, coordinating)	Category sourcing models, management models, common targets, sourcing strategy, supplier early involvement, proactive planning, common workshops, development discussions, partnership building and suppliers’ evaluations need to be part of supplier management.
Leadership (sensing, learning, integrating, coordinating)	Empowering and committing to a leadership culture is important. Management commitment, employee involvement in strategy work and empowerment through responsibility are important for leadership.
Capability to define processes and management structures (sensing, learning, coordinating)	Management needs to define processes and management structures. Structures are needed for risk, process and SRM. Defined and documented standardised processes, instructions, common targets, defined roles, critical tasks and competences, defined strategies and supplier management models create a base for management. A BCM structure and comprehensive BCPs are essential.
Competence development (sensing, learning)	Competence identification for the current state and future competence mapping and cross-competence development are important. Supplier plans for competence development, training and education, and competence development in collaboration with the supplier network are essential.
Performance monitoring (sensing, learning)	Continuous monitoring of supplier conditions (e.g. through supplier assessments, performance measurement and follow-up with corrective actions) is important.
Capability to find and use information from systems (sensing, learning)	ERP and SRM data availability and system integrations enable data usage and performance data management. It is important to collect performance data and identify risks from the data. SRM tools need to be accessed by suppliers.

5. Discussion

In recent years, global crises have been demanding for European industrial companies and their supply chains (Simmons

et al., 2022). The companies, both buyers and suppliers, have had to adapt rapidly to continuous changes and adjust their supply chains in response to unexpected situations. The global energy industry has faced major

challenges during these crises, yet these have also led to new business strategies and provided essential learning for the future (Hoang et al., 2021). Simultaneous to these major unexpected challenges, energy industry companies are experiencing transformation processes to increase renewable energy usage, forcing them to adapt to the changing business environment. To succeed in such a rapidly evolving business life and maintain competitiveness, dynamic capabilities and agility are needed to proactively sense potential threats and respond to them with correctly timed actions. This research aimed to increase understanding of the dynamic capabilities needed in SCRes management in energy industry and identify key microfoundations for SCRes. As a result, eight microfoundations of SCRes management in the Finnish energy industry were identified (Table 2.). From those network collaboration, communication and knowledge sharing, systematic SRM and leadership can be considered as key microfoundations for dynamic capability in the energy industry as they were discussed as a part for all four high-order dynamic capabilities: sensing, learning, integrating and coordinating.

When the results are discussed, it needs to be considered that the research was conducted and data were collected during the COVID-19 pandemic. Energy industry companies in Finland highlighted the importance of proactive communication and information sharing between stakeholder networks to better prepare for future crises. Supplier management through SRM was highlighted as important for developing management for the future. The importance of leadership was pointed out, as it had an essential effect on employees' motivation and resilience to ensure business continuity in challenging situations.

This research was conducted among the biggest energy industry companies in Finland. Similar research would be useful to

conduct in other countries to compare the results and findings. Generally, there are similarities in the energy industry in different countries, as the energy industry is critical for supply security. In the current global situation, energy industry companies face challenges in energy availability; they must simultaneously adapt and change their business strategies. In energy industry companies, it is typical to use external services and service providers, for instance, for maintenance services and operations. This means that energy industry production plants are shared industrial workplaces (Jounila et al., 2020), the management of which is challenging due to the involvement of several service providers. Therefore, SCRes is essential in the energy industry, regardless of the geographical context. Based on this research, it can be suggested that the research findings from Finnish energy industry companies are valuable for all energy industry companies interested in creating dynamic capabilities and managing SCRes.

5.1 Identified Microfoundations for High-order Dynamic Capabilities in SCRes Management in the Energy Industry

The current global situation and ongoing crises have forced energy to seek new supply chains to replace the most vulnerable ones. As a learning point from the global crisis energy industry companies have faced the fact that global threats can be realised quickly and unexpectedly, and they need to consider various capabilities in SCRes management. Concerning the first research question, this study deepens the understanding of the identified microfoundations needed to build dynamic capability and SCRes in the energy industry.

This study deepens existing knowledge of *sensing capability* in this context in the Finnish energy industry by emphasising interactive stakeholder network collaboration, committed leadership, systematic SRM, common risk and BCM

activities and performance monitoring related to sensing to increase the visibility of threats. Paralleling with earlier literature (Pavlou et al., 2011; Teece, 2018), this study highlights those interactive activities inside stakeholder networks that promote information flow and the identification of different kinds of threats related to SCs or competences. The findings indicate that in the energy industry, systematic SRM increases interaction between buyer and supplier companies and supplier incentives increase commitment and motivation.

Another interesting finding is that open discussions and mutual trust among stakeholders relate strongly to sensing. The findings of this study indicate that supplier performance monitoring at different organizational levels, through assessments and performance measurements, relates to sensing and SCRes management in energy industry companies. This finding concretises the energy industry empirically and supports previous findings in the general literature related to key performance indicator (KPI) usage and performance monitoring (Werner et al., 2021), as they make performance and weaknesses visible and thereby enable corrective actions. This study in the Finnish energy industry also found that the capability to use information from ERP systems relates to sensing threats. This finding deepens the understanding from previous studies (Ifraan et al., 2022) that in the energy industry, the capability to find and use information from systems improves information flow and increases agility and decision-making. The current study also found that leadership relates to sensing by motivating, committing and empowering internal and external employees to take responsibility for identifying threats.

Similar to sensing, *learning capability* was also found to be based on similar microfoundations of dynamic capability. In general, this study supports the existing literature confirming stakeholder collaboration impact on continuous learning (Bojesson & Fundin, 2020; Chrisandina et

al., 2022; Leemann & Kanbach, 2022; Pavlou et al., 2011; Pundziene et al., 2022; Teece, 2020). In this context, this study provides new insights into the energy industry by highlighting an interactive stakeholder network was seen as providing more knowledge and better visibility to identify and respond to threats, although the companies would partially be competitors.

As highlighted in this study, networks may consist of suppliers but may also relate to partners like the NESAs and HSEQ® cluster. The findings of the research deepen the understanding of the energy industry and complement earlier research (Adobor, 2019; Mubarak et al., 2021), pointing out that internal and external knowledge sharing and organizational learning have positive effects on SCRes.

As mentioned in the literature (Leemann & Kanbach, 2022; Pavlou et al., 2011; Teece, 2007)), *integrating capability* involves combining knowledge and skills from individuals but also with vertical and horizontal stakeholders to promote information sharing. Earlier research (Lotfi & Larmour, 2021; Simmons et al., 2022) pointed out that SCRes is improved by horizontal and vertical collaboration, for instance in company clusters that use and share the strengths of individual companies to minimise the effects of crises in the energy companies' SCs. This study supports the work of other studies in this area linking knowledge sharing and communication in integrated stakeholder network and interorganizational network with increased risk visibility, continuous learning and SCRes (Chrisandina et al., 2022; Piya et al., 2022; van den Adel et al., 2022).

The findings of this research complement earlier research and concretise the energy industry empirically by emphasising interactive collaboration internally, horizontally and vertically in NESAs pools, HSEQ® cluster and individual companies to create partnerships, manage external resources and promote responsiveness and

adaptation. The findings indicate that integrating with stakeholder networks is key for implementing changes agilely and building SCRes, which requires interactive collaboration with stakeholders to build trust and implement proactive planning. These findings are also supported by the previous literature (Tarigan et al., 2021; Chrisandina et al., 2022; Piya et al., 2022) in terms of internal integration, but they provide new insights into the energy industry by considering a wider stakeholder network. The current study found that systematic SRM with supplier early involvement supports integration with information, knowledge sharing and trust. However, this finding has not previously been described.

As discussed in the literature (Linden & Teece, 2018; Teece, 2016), *coordinating capability* highlights systematic organizing and leadership skills to commit employees for transformation. These results deepen the understanding of coordination capabilities in the energy industry by emphasising a committing and empowering leadership culture with early supplier and employee involvement, for instance, in strategy work and development activities. This is in accordance with earlier observations suggesting strategies, process design and standardized management systems impact SCRes (Chrisandina et al., 2022; Dittfeld et al., 2022; Zimon et al., 2022).

One interesting finding is that supplier commitment is a critical part of SRM in dynamic capability creation and SCRes management in the energy industry. The current study found that buyer and supplier company employees need to be committed and motivated to work towards common goals through empowering leadership. Earlier research points out that SRM is a strategic competence for creating SCRes (Kiers et al., 2022). These results further support the importance of communication to ensure information flow between operational and management levels, as well as between stakeholder networks. This study is consistent with that of van den Adel et al.

(2022) who found that managers activity to support information exchange between the stakeholder network is evident.

5.2 Key Microfoundations for SCRes in the Energy Industry

Concerning the second research question, the key microfoundations for SCRes in the energy industry were identified. The current study highlights network collaboration, open communication and knowledge sharing, systematic SRM and committing leadership as key microfoundations to advance sensing, learning, integrating and coordinating capabilities and to build SCRes in the energy industry (Figure 3). However, findings indicate that competence development, performance monitoring and management capabilities need to be considered in SCRes management. These findings deepen the understanding of these capabilities the energy industry, which is supported by the previous literature (Kiers et al., 2022; Liang et al., 2022) Ocicka et al., 2022) that points out the employees' competences, usage of available competences, the creation of new competences and the training of different strategic competences as key elements in organizations when building SCRes. Earlier research (Nikookar & Yanadori, 2021; Ozdemir et al., 2022) pointed out that managers need to invest in personal relationship creation with employees and suppliers to increase visibility, responsiveness and flexibility and thereby SCRes. The findings concretise the energy industry empirically and further support the idea that managers need to establish committing leadership by empowering and motivating internal and external employees, building trust, assigning responsibility and ownership for actions and finding solutions. These findings deepen previous studies (Sreenivasan et al., 2022) that consider team empowerment as critical in SCRes. Another interesting finding is that managers need the capabilities to define standardised processes and common targets and to motivate

employees to work together to reach the targets. Earlier research highlighted supply chain agility in response to threats and SCRes management (Kazangoclu et al., 2022; Piya et al., 2022). As Doeze Jager et al. (2016) pointed out, organizational trust improves SC agility and the ability to adapt to changes quickly. The findings of this research complement earlier research by emphasising the connection between dynamic capabilities and trust for improving agility and thereby SCRes in the energy industry.

The research results of this study highlight the importance of systematic SRM in the energy industry. Systematic SRM needs to be enlarged to empowering supplier leadership, motivate and commit suppliers to work together and build trust and commitment to reach targets. Suppliers need to be motivated through empowerment, supplier early involvement and incentives. It is important to define and communicate common targets to support collaboration between buyer and supplier companies.

Earlier research (Simmons et al., 2022) pointed out that networking and cluster collaboration support competitiveness and prevent disruptions in case of crises. The current study found, which deepens the understanding in the energy industry, that network collaboration needs to be done with a wider network of internal and external stakeholders (e.g. for business continuity, competence and resource planning). External stakeholder networks within the HSEQ® cluster, NESAs and competitors provide more perspectives and learning possibilities when information is shared between a wider group of stakeholders. Open discussions build trust between internal and external stakeholders, which increases visibility. Knowledge and information need to be shared in a wide stakeholder network. Internal and external employees need to share their knowledge, learn from each other and identify threats and solutions. These findings concretise the energy industry with that of Roh et al. (2021) and Piya et al. (2022), who highlight

visibility, collaboration and knowledge as absorptive and key capabilities in SCRes management.

5.3 Managerial Implications

The findings of this study have several important implications for future practice. Dynamic capability has a significant effect on SCRes and companies' competitiveness in the current unpredictable business environment. There is, therefore, a definite need for interactive network collaboration and committing leadership internally and with suppliers to build dynamic capability and SCRes by sensing, learning, integrating and coordinating.

Greater efforts are needed to ensure interactive collaboration with internal and external stakeholders. Managers need to actively promote networking with suppliers, but also with competitors and company clusters (e.g. the HSEQ® cluster, NESAs and other companies in the industrial field) to promote open dialogue, brainstorming and knowledge sharing. Joint competence management in collaboration with buyer company and suppliers is necessary to promote the identification of available resources, possible gaps and future needs. Collaboration is also needed in BCM and BCP activities.

One important practical implication is that management's commitment and leadership create a base for committed culture and employee commitment, and consequently knowledge sharing, openness, continuous organizational and interorganizational learning and mutual trust. Employees and suppliers need to be involved in development work in the early phase. Managers need to empower them by assigning responsibility for decision-making and activities but also by motivating them to find information from systems, use it and identify threats. Supplier performance monitoring needs to be done at every organizational level and assessments need to

be used to follow-up on responsiveness.

Systematic SRM combined with empowering leadership needs to be implemented to obtain suppliers' commitment to work towards common goals. Buyer and supplier companies need to have the same target to ensure a common direction. Therefore, management needs to have the competence to define processes, identify key tasks and competences and define priorities and strategies with common targets.

Management is in a key role in creating dynamic capability and motivating employees and stakeholders. However, every employee is responsible for his or her own input and commitment to building dynamic capability. The findings of this research need to be considered in SCRes management. This study provides knowledge for management about which capabilities need to be developed to build dynamic capability and SCRes in buyer or supplier companies.

5.4 Limitations of this Study and Proposals for Future Research

This study includes some potential biases that need to be highlighted. The research was conducted using qualitative interviews and analyses. First, the scope of this study was limited in terms of buyer companies involved in interviews; suppliers were not included. Second, subjective interpretations may be included in this analysis.

These findings provide the following insights for future research. As a future research topic, we recommend changing the unit of analysis to the company level to examine possible differences between energy companies. In addition, we see that the existence of potentially conflicting views inside the company should be examined. A further study could assess the impact of innovation capabilities inside the SC on identifying and responding to threats. Considerably more work will need to be done to determine how microfoundations for

dynamic capability are created at the individual, process, interaction and structural levels in this context.

In this research, there was no comparison between buyer companies of different sizes or between buyer and supplier companies. Supplier interviews could provide different perspectives. Further research might explore the strengths and weaknesses of dynamic capabilities in different-sized energy companies. More research could be done on how different dynamic capabilities affect one another.

It should be noted that research data were collected from a wide range of respondents. Despite companies having defined interview participants, it is possible that the competencies of the respondents were not sufficient to manage this complex phenomenon of SCRes and dynamic capabilities. In this research, the focus was on finding similarities between companies. In the future, the research data from this study could be used to further research how perceptions of resilience vary among different functions in a company.

6. Conclusion

In recent years, energy industry companies have faced major global crises and the need to update business strategies to increase renewable energy usage. This has required fast responsiveness, agility and adaptability to maintain SCRes in unexpected situations. Dynamic capabilities are essential in SCRes management and long-term competitiveness. The network of buyer and supplier companies in the energy industry need to strengthen their SCRes and build the capability to proactively identify threats, respond to threats agilely with immediate actions and implement changes in the business to maintain competitiveness in a continuously changing business environment.

The main goal of the current study was to determine the dynamic capabilities needed in

SCRes management and identify key microfoundations critical in SCRes. As a response to this goal, this study identified eight microfoundations needed for SCRes management in the Finnish energy industry to implement agile changes and transformation. These microfoundations are collaboration with stakeholders, communication and knowledge sharing, systematic SRM, leadership, the capability to define processes and management structures, competence development, performance monitoring and the capability to find and use information from systems. Management needs to be committed to managing microfoundations to promote dynamic capability at different levels of organizations.

The findings of this study have shown that network collaboration, open communication and knowledge sharing, systematic SRM and

leadership are key microfoundations for creating simultaneous sensing, learning, integrating and coordinating capabilities in SCRes management in the energy industry. Management, teams and individuals need to pay attention to developing vertical and horizontal collaboration with stakeholder networks and implementing common activities. Communication and knowledge need to be shared interactively between stakeholder networks. Systematic SRM needs to be done interactively and should include early supplier involvement and management with common targets. Leadership needs to be empowering and committing to involving employees.

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Appendix 1. Interview questions for the energy industry companies

A. Information of interviewee

1. Name
2. Position and responsibility area
3. How long you have been working in this position?
4. Do you give permission to record the interview?
5. Do you give permission to use interview results in public thesis?

B. Supply chain management

6. What capabilities are critical to be considered in SC management to ensure high SCRes?
7. What elements weaken SCRes?
8. How to minimize failures proactively in energy production and distribution?
9. Have you defined and described the processes? How?
10. How you measure SCRes? What KPIs are used?
11. What development actions are planned to develop SCRes?

C. Personnel management

12. What capabilities are critical to be considered in personnel management to ensure high SCRes?
13. How personnel competence is maintained, developed and followed?
14. How you ensure adequate resources in normal and in emergency situations?
15. How personnel is involved to decision making and development?
16. How personnel participate to SC development?
17. What development actions are planned to be done in personnel management to develop SCRes?

D. Continuity management

18. What capabilities are critical to be considered in continuity management to ensure high SCRes?
19. Do you have a business continuity plan (BCP)?
20. How you measure business continuity? What KPIs are used?
21. What development actions are planned to be done in continuity management to develop SCRes?

E. Risk management

22. What capabilities are critical to be considered in risk management to ensure high SCRes?
23. How risk management is organized?

24. What SC risks are recognized?
25. How have you prepared for realization of risks?
26. How risk effects are recognized and evaluated?
27. How you measure risk management? What KPIs are used?
28. What development actions are planned to be done in risk management to develop SCRes?

F. Asset management

29. What capabilities are critical to be considered in asset management to ensure high SCRes?
30. How the condition of assets is taken care of?
31. What is required to promote long service life of assets?
32. How you measure asset management? What KPIs are used?
33. What development actions are planned to be done in asset management to develop SCRes?

G. Safety

34. What capabilities are critical to be considered in safety and security to ensure high SCRes?
35. How to improve SCRes by safety??
36. How you measure safety? What KPIs are used?
37. How safety is maintained?
38. What development actions are planned to be done in safety and security to develop SCRes?

H. Supplier management, stakeholder collaboration and sourcing

39. What capabilities are critical to be considered in supplier management, stakeholder collaboration and sourcing to ensure high SCRes?
40. Who are the most necessary partners?
41. How suppliers and stakeholder collaboration are managed?
42. What is the importance of partnerships in SCRes?
43. How SCRes is developed with suppliers and stakeholders?
44. How suppliers/stakeholders are prepared for risks?
45. How suppliers/stakeholders risk exposure is followed?
46. How sourcing is organized?
47. How you measure supplier and stakeholder management or sourcing? What KPIs are used?
48. What development actions are planned to be done in supplier and stakeholder management or sourcing to develop SCRes?

Appendix 2. Interview questions for National Emergency Security Agency

1. What capabilities are critical to be considered and improved in the following areas to ensure high SCRes in the energy industry in Finland:
 - a. in SC management?
 - b. in risk management?
 - c. in continuity management?
 - d. in safety?
 - e. in asset management?
 - f. in supplier collaboration?
 - g. in procurement?
2. How SCRes should be developed in energy industry in Finland?
3. How collaboration between energy industry and National Emergency Supply agency should be developed?