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Sourcing for high technology innovation: Engaging to absorb knowledge pre-contract

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A R T I C L E I N F O

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A B S T R A C T

This study investigates how firms can identify, access, and capitalize on viable innovation in the high technology supply market during the pre-contractual phase of relationships. The industrial landscape is changing rapidly due to technological advancements like automation and electrification, leading traditional industries to explore new avenues for knowledge and partner selection. However, identifying, assessing, and trusting suppliers with whom firms can enter a relationship is a complex task. Therefore, the study adopts the absorptive capacity perspective for conceptualizing the supplier selection process, focusing on the pre-contractual phase. Based on two in-depth case studies in the automotive industry, we find that supplier selection can be assisted with higher levels of engagement, coordination, and alignment internally with different firm stakeholders and externally with the larger supply market. This study illustrates that new actors bring disruptive innovation into the automotive industry, and the knowledge is absorbed during supplier selection, facilitated by fostering higher levels of engagement, coordination, and alignment both internally among various stakeholders within the firm and externally within the broader supply market. This study significantly advances the understanding of supplier selection practices in the context of high technology innovation. The theoretical contributions made through our empirical investigations enhance the knowledge base on sourcing strategies, shed light on the complexities of supplier selection, and offer practical implications for firms aiming to navigate the rapidly changing landscape of technological advancements.

1. Introduction

The rapid evolution of the industrial landscape, driven by technological advancements like automation and electrification, has compelled traditional industries to seek new avenues for knowledge and its suppliers. Absorbing the needed knowledge on technology in the market, to make the sourcing decision, has proven to be a difficult undertaking. This search for suppliers may involve startups, innovation hubs, or companies from different industries and markets (Pulles Niels, & JasperHolger, 2014; Flor et al., 2018; Kurpjuweit et al., 2021; Arvidsson et al., 2022). The process of supplier selection is crucial for firms, as it can either enhance their bottom line or result in monetary losses and customer attrition (Van Weele, 2010). However, identifying, assessing, and establishing trust with suppliers in this new environment is a complex task. Moreover, firms often need to invest significant resources to explore alternatives outside their existing supply markets, which carries inherent risks when entering relationships with suppliers unfamiliar with the buyer's industry, products, or services. Unfortunately, there is limited knowledge on guiding the supplier selection process to identify and harness market innovation in this evolving landscape, as empirical studies on sourcing from unconventional innovation arenas are scarce (Arvidsson et al., 2022; Homfeldt et al., 2017; Kurpjuweit et al., 2021; Servajean-Hilst & Calvi, 2018).

Previous research has highlighted a research gap concerning the role of supply management in the context of discontinuous, radical, and disruptive technology (Calvi et al., 2018). Studies have found that only a few companies have a formalized approach to identify or select suppliers for high technology (Goldberg & Schiele, 2018; Kurpjuweit et al., 2021). Although some studies have explored how already identified suppliers contribute to a firm's competitive advantage in new product development or innovation (Wynstra et al., 2001; Villena et al. 2011), there are few studies that focus on how firms can better identify and integrate innovation from potential suppliers prior to establishing a contractual relationship (Luzzini & Ronchi, 2011; Patrucco et al., 2022).

This study aims to address this gap by examining how firms can configure their capabilities and resources to effectively identify, access,

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and capitalize on viable innovation in the high technology supply market during the pre-contractual phase of relationships. Specifically, we investigate the innovations resulting from both the demand for electrification and automation and the technological advancements pushed by suppliers. The relationship between technology and demand as sources of innovation has been extensively studied, with research identifying capabilities and resources as key ingredients (Di Stefano et al., 2012). Often, firms generate these capabilities and resources internally to respond to signals from technology and demand (Teece David, Gary & Amy, 1997). Our study focuses on the capabilities and resources of buying firms to absorb signals from both demand and technology.

To provide theoretical foundations for our study, we draw upon the concept of Absorptive Capacity (AC), which is defined as a firm's ability to recognize, assimilate, and apply new external information to drive innovation and make commercial gain (Cohen Wesley & Levinthal Daniel, 1990). In this study, AC is analyzed at the firm level, and understood as the accumulated knowledge of the firm through the individuals, processes, routines, and activities during supplier selection and prior to a transactional agreement. Absorptive capacity plays a crucial role in supplier selection for high technology (Rothaermel Frank, & Tereza, 2009; Flor et al., 2018), as firms must not only identify external sources of technology but also successfully assess the potential to assimilate and apply it to their own products (Gebauer et al., 2012), often originating from different markets. This capacity relies on organizational routines, processes, and capabilities that span various stages (Zahra & George, 2002), including the identification of external technology sources, knowledge assimilation, and knowledge application/integration. These stages are relevant in the supplier selection process for high technology (Patterson & Ambrosini, 2015). In this study, we adopt the AC process as a framework for conceptualizing the supplier selection process, focusing on the pre-contractual phase, and excluding the post-contractual phase of knowledge identification, assimilation, and integration.

The findings of this study shed light on how firms can organize their supplier selection process to better identify and integrate technology innovations from the supply market before entering risky contractual relationships. Consequently, our research contributes to the existing literature on sourcing disruptive innovation (e.g. Calvi et al., 2018; Finger et al., 2014; Schiele, 2010) and procurement from startups by elucidating the roles and capabilities of supply management. To empirically explore these dynamics, we conduct a comparative analysis of high technology procurement at two different automobile manufacturers. The automobile industry serves as an illustrative example due to its reliance on new technologies provided by emerging firms in consolidated supply markets. As technological disruptions and new market entrants pose significant supply risks to automobile manufacturers (Kompalla et al., 2016), it is essential for supply management to not only understand new technologies but also comprehend the supply market on multiple levels, including new industries and markets, intermediaries and retailers, and mergers and acquisitions.

The paper aims to contribute to the literature on supplier selection for high technology innovation in the pre-contractual phase of relationships. It proposes a framework for supplier selection based on empirical observations and findings. The framework illustrates the progression from identification of technology and potential partners to the assimilation and integration of high technology knowledge for signing contracts with suppliers. The paper also discusses the evolving role of supply management in the sourcing of innovation, particularly in relation to start-ups, and highlights the importance of cross-functional coordination and collaboration (adding to the discussion by e.g., Driedonks et al., 2014). Furthermore, the paper extends the application of absorptive capacity (AC) framework to the context of supplier selection for high technology innovation. It emphasizes the need for supply management to go beyond the identification of new technology suppliers and include activities such as assimilation, integration, and knowledge transfer. The theoretical contributions of the paper lie in providing insights into the evolving role of supply management in capturing disruptive innovation, the specific considerations for selecting start-ups as suppliers, and the application of the absorptive capacity framework to supplier selection in the context of high technology.

The subsequent sections of this paper present a comprehensive review of the existing literature on supply management of high technology innovation and absorptive capacity. We then describe our methodology, present detailed case findings, and conclude with a discussion of the implications of our research.

2. Theoretical background

2.1. Absorptive capacity of firms and sourcing innovation

Absorptive Capacity (AC) is defined as the firm's ability to locate and incorporate new ideas into its processes (Cohen Wesley & Levinthal Daniel, 1990; Zahra & George, 2002). AC is a set of organizational routines and processes (i.e. capabilities) (Zahra & George, 2002) with multiple stages, starting from i) identification of external technology and technology sources, ii) the assimilation or transfer of the knowledge to the own company, and iii) the final stage of application/integration of the acquired knowledge (Cohen Wesley & Levinthal Daniel, 1990). We build our conceptualization on this AC process.

AC draws attention to both the internal and external environment, highlighting the internal processes of learning from experience and current actions, and the need to access knowledge from the external environment including from acquisitions and other inter-firm relationships (Easterby-Smith, 2008). With this perspective, the individuals are gatekeepers, distribute, and carry much of this knowledge, and the AC of an organization is largely based on the accumulated knowledge within that organization as a whole (Cohen Wesley & Levinthal Daniel, 1990). Consequently, organizations that have a higher degree of prior or existing technology, are more successful at acquiring new technology from the market, since they may have a better initial idea of the technology that they need for their new products or processes. Thus, the investments in R&D increase the AC of the firm, adding to its competitive advantage (Spithoven et al., 2011). In later studies, other areas of the firm have also been identified as important for development of the AC, leading to the process view of the abilities (Zahra & George, 2002). Pihlajamaa et al. (2017) find the AC of the supply management function to be a successful alternative to high internal R&D intensity for the technology advancement of firms. AC has also been identified relevant for success of the network in addition to the firm (Hurmelinna--Laukkanen et al. 2012). However, in situations characterized with high uncertainty, such as those related to supply management of high technology, disagreements between functions arise regarding who has the final say in supplier selection (Brewer et al., 2019).

In the context of radical innovation, such as high technology, the firm's AC largely lie in the individuals responsible for identifying and integrating external environments, such as procurement engineers, advanced sourcing, or new product buyers (Schiele et al. 2021). Therefore, it is crucial for supply management to develop the necessary AC for technology advancement (Calvi et al., 2018). Duan et al. (2021) point to the importance of establishing knowledge management systems, developing organizational learning mechanisms, and improving the ability of employees to acquire and apply knowledge to improve absorptive ability. In contrast to incremental innovation, where procurement's role increases as the process moves from identification to integration of market innovation, some argue that procurement should have a larger role in the identification phase of radical innovation (Pihlajamaa et al., 2017; Schiele et al. 2021). The innovative potential for radical innovation is often found in unfamiliar areas, such as new markets, requiring supply management to take actions towards partner identification and the acquisition strategy, with the supplier driving the development project upon partnership (Bessant et al., 2005; Pihlajamaa et al., 2017). Bals et al. (2019) identify negotiation, communication, relationship management, strategy, and analytics as critical competencies for supply management to capture and integrate innovation. Recent studies also highlight the importance of involving procurement in supplier selection for innovation and performance evaluations (Arvidsson et al., 2022; Patrucco et al., 2022).

While technological knowledge is important in such complex sourcing, responsive market orientation as well as proactive market orientation are also suggested to be important determinants of AC (Lichtenthaler, 2016). Prior et al. (2018) point to the importance of individual interactions for buyer firm AC in complex sourcing situations. Here, purchasing has an important role to not only facilitate a firm's AC but also its connective capacity by accessing supplier knowledge (Picaud-Bello et al., 2022).

Prior knowledge about current trends and technological developments on the market, influence how well firms can recognize and absorb new information and apply it to their commercial contexts (Cohen Wesley & Levinthal Daniel, 1990; Kim et al., 2016) and to predict future technological developments (Tu et al., 2006). Firms with well-developed technical capabilities can process external knowledge and capture market innovation better, as individuals that do not have the correct contextual knowledge would not understand the new information similarly (Cousins Paul, Lawson, Petersen Kenneth, & Handfield Robert, 2011). Lack of relevant prior knowledge can create uncertainty and discourage deeper investigations into technological developments (Tu et al., 2006). Jones and Barner (2015) suggest that without the knowledge of the market and the requirements of technology, sourcing is limited to the existing supplier base of the firm. Such knowledge can, however, be about who knows what and who/where to turn to for certain information (Hurmelinna-Laukkanen et al. 2012).

AC is concerned with both in the interplay between the internal and external environments of the firm (i.e. horizontally) and in the interplay between individuals and the firm (i.e. vertically) (Martinkenaite & Breunig, 2016). Events which trigger firms to respond to external information are referred to as activation triggers. Khraishi et al. (2023) study smaller organization in the context of offshoring and find vertical knowledge creation capabilities to have a vital role in gaining innovation outcomes for the firm. Their findings, however, question the value of formal processes. Within these two environments, as depicted in Fig. 1, the first step of absorbing information from the external environment, such as market knowledge, is to identify and recognize its value for the firm (Zahra & George, 2002). Thereafter, there is a need to deploy processes which can analyze, process, and understand it for the firm, which is referred to as the assimilation capacity (Camisón & Forés, 2010). This requires firms to have processes which can integrate different types of information, as these can be different in content (Fundin & Elg, 2006), e.g. codified. Finally, the assimilated knowledge needs to be integrated with the existing knowledge, and exploited, emphasizing the application/integration of knowledge (Zahra & George, 2002). Throughout this process, the firm will gain improvements of existing operations, processes, and knowledge, and/or the development of new ones (Camisón & Forés, 2010).

While the relevance of these discussions is evident to supply management of high technology, the process, nuances, interplay between the horizontal and vertical, and the subsequent requirements are not clear. In the next section we will review the recent research on supplier selection of technology, identify the processes and routines, and link this back to the AC by introducing a theoretical frame of reference in Fig. 1. Thereafter, in the empirical study, we extend these discussions for the context of supplier selection for high technology using two cases.

2.2. Supplier selection for high technology

Firms, often, choose suppliers from approved supplier lists, which are updated and extended during supplier selection by the supply management team. These lists are created throughout the history of the company's relationships and based on input from several different internal stakeholders including procurement, engineering, and management (Van Weele, 2014). Traditionally, the supplier selection process has been suggested to focus largely on qualification and scanning of the supply options in this process (see e.g. Petersen et al., 2005; Song & Di Benedetto, 2008). A recent review demonstrates the breadth of supplier selection strategies and the growing complexity of this process (Saputro et al., 2022), where firms need to consider including resilience and sustainability in this process (Bonab et al., 2023; Saputro et al., 2022). Luthra et al. (2017) show how sustainability and innovation is combined in supplier selection criterion, including innovation activities for new cleaner technologies, processes, practices, and methods. Studies point to supplier selection for small and medium-sized enterprises (SMEs) to be an intuitive process (Ellegaard et al., 2022), while supplier selection for start-ups is more of a relational and dynamic process (La Rocca & Snehota, 2021).

In the context of technological uncertainty, firms often need to deviate from their usual supplier selection processes and routines, as such uncertainties can lead to complex and unpredictable technology developments, resulting in deeper dependence on collaborations for innovation (Bstieler, 2006; van Echtelt et al., 2008). Selecting the right partner for a sensitive relationship requires input from multiple functions within a company, as the required knowledge is often dispersed across the organization (Eisenhardt, 1995; Melander & Tell, 2014). While procurement typically has the most interaction with potential suppliers in the selection process, R&D is often considered the primary

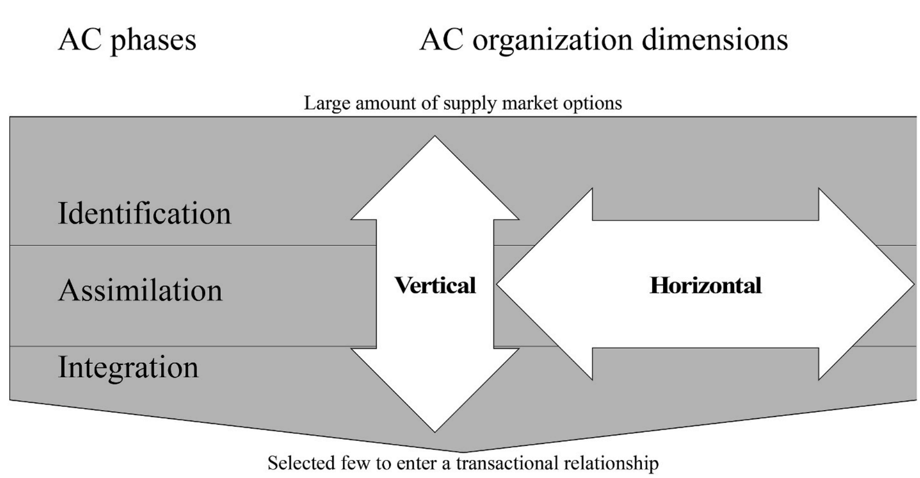


Fig. 1. Theoretical frame of reference.

function responsible for approaching and selecting suppliers that bring new technology (Ragatz et al., 2002). However, cross-functional collaboration in supplier selection can be influenced by political dynamics within the firm, with team members promoting their own functions' interests (Driedonks et al., 2014; Franke & Foerstl, 2020b).

To effectively manage supplier selection and sourcing high technology, supply management should play a dual role of supporting NPD while also being responsible for cost and integration over the product life cycle (Picaud-Bello et al., 2019). This can be accomplished by organizing supply management into advanced sourcing, life-cycle sourcing, and operative procurement functions (Schiele, 2010), as well as adopting a formalized approach for cost-managed categories and a more informal cross-functional approach for innovation-managed categories (Ateş et al., 2018). Overall, these studies suggest that supply management should have an active role both within and outside of the firm in managing NPD costs and initiatives.

Luzzini et al. (2015) argue that a clear innovation strategy and a strategic supplier selection approach are vital in such situations to hedge the risks. Mikkelsen Ole and Johnsen Thomas (2019) find that it is not always possible to maintain the traditional emphasis on qualifications when suppliers are being selected from outside the supplier base. When firms aim to select suppliers for "unique" innovation activities, Patrucco et al. (2022) argue that firms need a comprehensive set of metrics to select the best supplier. Schiele (2010) observes that firms use separate functions or groups for supply management of innovation (i.e., advanced sourcing) as compared to their life-cycle sourcing. Goldberg and Schiele (2020) point to the need for supply management to change towards more relational aspects in this context, such as moving from focusing on price negotiations towards joint cost calculations with suppliers.

In this context, the phases of the AC and the horizontal and vertical processes enabling AC, can guide our understanding of how firms can move from the uncertainties associated with the large amount of supply market options to the selection of few innovation partners (as depicted in Fig. 1).

3. Methodology

Since the aim in this study was to explore the impact of such a contemporary phenomenon and understand how supplier selection has been affected, we opted for a case study design (Ellram, 1996). Additionally, as argued by Gebauer et al. (2012) the investigation of the absorptive capacity is a complex, context bound issue that can benefit from an exploratory qualitative research approach. The study is based on two empirical and in-depth cases with different approaches to supplier selection for high technology to gain in-depth understanding of the phenomenon (i.e., part of existing processes, and in separate processes and unit). The unit of analysis of this study is the process of sourcing technology at the firm level.

3.1. Sampling of cases

The study employed theoretical sampling to select cases from the automotive industry, which was chosen due to its structured and well-organized supply management strategies. Supply management has been in focus for the automotive industry for decades, where firms have developed strategies for supplier selection (Choi & Hartley, 1996). More recently, the emergence of new high technologies such as electrification and automation that are provided by new supplier groups make automotive interesting to study. Compared to other industries, automotive manufacturers are used to sourcing innovative technologies from suppliers, making it an ideal industry for the study. The sampling of case companies is based on 1) the presence of the phenomenon (i.e., problems in identifications and integration of high technology innovation), 2) having established supplier selection processes in place, 3) high level procurement managers' commitment to collect in-depth data, and 4) different approach in sourcing of technology for development projects. Initially, the case studies were conducted separately focusing on their supplier selection of the respective technologies, and to gain empirically grounded descriptions of the specific processes. In both cases, through meetings with the procurement managers, it became clear that both firms were struggling to find, assess and select suppliers for these new high technologies for innovations, and had established processes otherwise, satisfying the first and second selection criteria. The two firms were positive towards the study, as well as towards allowing access to suppliers hence satisfying the third selection criteria. Case A was carried out in Spring of 2019, and followed by the initiation of Case B, which had a different sourcing approach. Considering that previous research has debated the benefits of the different approaches for absorption of innovation (e.g., Schiele et al. 2021), these two firms were selected for joint analysis in this study. We moved from within case analyses to cross-case analysis to explore emergent themes and to develop empirical theory with higher validity.

3.2. Case descriptions

Both cases are from Northern Europe and the automotive industry, hence decreasing the contextual differences impacting the findings. Case A deals with the supplier selection of a specific new technology (test equipment for a new part in the automobiles) within the passenger vehicles produced by an established automaker: firm Alfa. Case B concerns the supplier selection for innovative components and services for automation and/or electrification of larger freight vehicles produced by an established OEM: firm Beta. Descriptive information on the cases is summarized in Table 1.

The mature technology has been around for many years with incremental innovations, while the innovative technology is in its early development phases and include anything from concept development to initial market introduction. For example, while Transmission and Base Engine categories would be considered as mature technology, electrical and electronics would be innovative. The supply for mature technology comes from the firms' existing suppliers who have generally been there for multiple decades. On the other hand, the supply for new or innovative technology needs new market scanning to identify the potential technology and the potential sources.

In case A, supply management is split into different areas, where Tooling and Test, where the technology in this study is sourced for, is one of these. This department works closely with software and hardware technicians, to source the right goods and services. The technical knowledge of the engineers and the supplier evaluation and contracting knowledge of the purchasers, help meet cost, quality, and environmental requirements. (Personal communication with innovation sourcing manager, 2019-01-25). For the technology in question, there is an increased technical complexity and new suppliers on the market. This has led to purchasers voicing concerns on their understanding of the supply market and the test equipment.

In case B, it was similarly important to have experience and the right knowledge. The technologies sources for automation and electrification have meant less knowledge of the products and the supply market among the purchasers. The lack of technical knowledge of the purchasers also has a direct impact on market scanning and sourcing abilities. However, it can be of "*huge value [to] not know what's going on*" when sourcing innovation, and "*if you know too much you put yourself in a box*". The tacit knowledge of the individuals was stressed in this respect as stated by the head of the innovation purchasing unit, that it is not until you spent a few years at a position that you have the right understanding of the market to effectively scan it. The company has job rotation among its functions, which impacts this knowledge.

3.3. Data collection

As understanding the different layers of the change in supplier

Table 1
Case descriptions.

Cases	A	B
Case characteristics	• Procurement process of test equipment for automation of vehicles • Limited supply options, not easily identified • The need for broader supply market knowledge for the procurement process	• Procurement process of automation, electromobility and electrical components for vehicles • Limited supply options, not easily identified • The need for broader supply market knowledge for the procurement process
Case firms	Automotive OEM Alfa	Automotive OEM Beta
Size	• 30k employees • 600k cars sold annually • 200b SEK annual revenue	• 50k employees • 226k trucks sold annually • 390b SEK annual revenue
Supply management organization	• CPO reports directly to top management • Strategic decisions and contracting are centralized • Cross-functional between procurement, SQM, and R&D • Long-term relationships of more than 30 years with the top 10–15 suppliers	• CPO reports directly to top management • Strategic decisions and contracting are centralized • Cross-functional between procurement, SQM, and R&D • Long-term relationships with the top suppliers • The organization has a dedicated group for supply management of innovation who reports directly to the CPO and overlooks supply management of innovation in other categories
Key supply management characteristics for high technology	• Part of production process • Cross-functional • Long-term relationships • Decision criteria: Cost and supplier relationships • Strong supplier dependence	• Centralized with a separate group dedicated to supply management of innovation • Cross-functional • Long-term relationships • Decision criteria: Cost and supplier relationships • Strong supplier dependence

selection for innovation requires a high level of communication with respondents, semi-structured interviews were designed (as suggested by e.g. Easton, 2010). In addition to interviews, we collected secondary sources consisting of internal and official documents. The buyer interview guide started with more general questions about the organization of supply management and supplier relationships. Thereafter, more specific questions related to accessing high technologies, internal and external challenges, start-ups, as well as conflicts were discussed. The questions posed to the supply side interviewees covered their development process and challenges, interactions with the buyer, competition, and market dynamics. Notes from the early interviews were used to shed light on emerging themes and adapt or add questions to ask in later interviews (Bryman & Bell, 2007).

Sequential purposive sampling was used in combination with snowballing to select interviewees in each identified actor group (i.e., procurement, R&D, legal, supplier companies, experts). The interviewees were selected to cover understanding of the change which supplier selection is experiencing from the buyer side, and the changes in the supply market, from the supply side. We aimed to include highly knowledgeable informants with diverse perspectives (Eisenhardt & Graebner, 2007).

In total 25 interviews were conducted in case A (12 from firm Alfa and 13 from the supply side) and 14 in case B (12 from firm Beta and 2 from the supply side). All interviews were done in Spring and Fall 2019 (March–October). Table 2 displays the respondents of the cases. The interviews were recorded and transcribed (i.e., a software called oTranscribe was used for initial transcription and then reviewed by the researchers to ensure consistency). Supplier interviews in this study served to understand the supply market and to validate the information gathered from the buyers. The larger number of supplier interviews in Case A are due to the case relating to a specific technology and the need to understand that specific market and its developments. The interview guides can be found in the appendix.

The different secondary sources that have been used are market reports written by consultancy firms and industry experts, news articles, company websites and video-recordings of interviews with CEOs of the companies (see appendix for more details). To verify the collected information from the secondary sources, questions related to the findings were asked during the interviews performed. The triangulation between informants, and with differing data sources was used to increase data validity. Understanding of the data and initial analysis were shared with the firms in biweekly meetings during data collection to further ensure quality of the interviews. Later, the within case analysis was presented to the related management at the firms and the feedback was used in refining our understanding when needed.

3.4. Data analysis

The transcripts were translated when necessary, and analyzed using open coding, by sorting the answers under corresponding themes. First, within case analyses were conducted for the two cases, focusing on key supply management characteristics, market characteristics and functions involved and their responsibilities. After identifying the clear connotations justifying a cross-case analysis, we combined the two. By reviewing the cross-case analysis (see Fig. 2): 1) similarities in the absorptive capacity phases and dimensions were identified, and 2) at nuances were data emerged more clearly in one case they were either combined or triangulated with the other case (e.g., cross-functional coordination for socialization with identified partners in the assimilation phase of AC emerged from Case B, while the same cross-functionality in the same phase emerged from Case A related to identification of technology).

Here, first order coding was empirically driven (Gioia Dennis, Corley Kevin, & Hamilton Aimee, 2013), where labels related activities, challenges for supply management of high technological innovations, and requirements for the new procurement situations compared to existing processes and practices (first order codes in Fig. 2). Following this, we started our second order coding (i.e., axial coding), grouping data into theoretically driven codes (second order codes in Fig. 2) based on: the AC phases of identification, assimilation and integration (Zahra & George, 2002), and the horizontal and vertical dimensions of AC (left and right sides of Fig. 2) (Martinkenaite & Breunig, 2016). The second order coding is based on theoretical concepts, such as cross-functionality (Franke & Foerstl, 2020a), value (Zahra & George, 2002), engagement (Meqdadi et al., 2020), absorbing information (Flor et al., 2018), interaction in networks (Melander & Arvidsson, 2022), socialization (Cousins et al., 2006), and potential supplier partnerships (Ellram, 1990).

Finally, we again used empirical coding (i.e., selective coding), and based on the observations from the case, the roles that the supply management function was taking during each intersection of the frame of analysis (e.g., vertical identification or horizontal identification) were given a representative “label” (aggregated level in Fig. 2). At the aggregated level, the levels of engagement within each concept and the link between the horizontal and vertical dimensions were assessed. Our move from data to the framework is summarized in the appendix.

Table 2
List of respondents.

Case A: 23 interviews in total	Case B: 14 interviews in total
Respondents at Alfa (12 in total):	**Respondents at Beta (12 in total):**
1. Top Management representative 1 (PM_1) Senior procurement manager, in person, 30 min minutes	1. Top Management representative (PM) Senior procurement manager, in person, 45 min minutes
2. Top Management representative 2 (PM_2) Senior procurement manager, in person, 30 min minutes	2. Innovative procurement representative 1 (IP_1) Senior procurement manager, in person, 60 min minutes
3. Procurement representative 1 (P_1) Senior strategic buyer (specific product), in person, 60 min minutes	3. Innovative procurement representative 2 (IP_2) Senior procurement manager, in person, 60 min minutes
4. Procurement representative 2 (P_2) Senior strategic buyer (specific product), in person, 60 min minutes	4. Innovative procurement representative 3 (IP_3) Project manager, in person, 60 min minutes
5. Procurement representative 3 (P_3) Senior strategic buyer (specific product), in person, 60 min minutes	5. Procurement representative 1 (P_1) Electric commodity buyer (vehicle), Skype, 60 min minutes
6. Procurement representative 4 (P_4) Senior strategic buyer (specific product), in person, 60 min minutes	6. Procurement representative 2 (P_2) Electric segment leader (vehicle), Skype, 60 min minutes
7. Procurement representative 5 (P_5) Senior strategic buyer (specific product), in person, 60 min minutes	7. Procurement representative 3 (P_3) Electric Procurement manager (powertrains), in person, 60 min minutes
8. Procurement representative 6 (P_6) Senior strategic buyer (specific product), in person, 60 min minutes	8. Procurement representative 4 (P_4) Business Improvement Leader (Business office and IT), in person, 30 min minutes
9. R&D representative 1 (E_1) R&D engineer (specific product), in person, 45 min minutes	9. Procurement representative 5 (P_5) Project manager (Business office and IT), in person, 30 min minutes
10. R&D representative 2 (E_2) R&D engineer (specific product), in person, 60 min minutes	10R&D representative 1 (E_1) Powertrain R&D manager, Skype, 60 min minutes
11. R&D representative 3 (E_3) R&D engineer (specific product), in person, 60 min minutes	11. R&D representative 2 (E_2) Vehicle R&D manager, in person, 60 min minutes
12. Legal representative (L) Legal manager (specific product), in person, 60 min minutes	12. Legal representative (L) Contract manager, in person, 60 min minutes
Supplier respondents (11 in total):	**Supplier respondents (2 in total):**
1. Supplier representative 1 (S_1) Sales manager of potential supplier (specific product), Skype, 30 min minutes	1. Supplier representative 1 (S_1) Startup CEO (electrical component), Skype, 60 min minutes
2. Supplier representative 2 (S_2) Sales manager of potential supplier (specific product), Skype, 30 min minutes	2. Supplier representative 2 (S_2) Sales manager of existing supplier (electrical component), Skype, 30 min minutes
3. Supplier representative 3 (S_3) Sales manager of potential supplier (specific product), Skype, 30 min minutes	
4. Supplier representative 4 (S_4) Sales manager of potential supplier (specific product), Skype, 30 min minutes	
5. Supplier representative 5 (S_5) Sales manager of potential supplier (specific product), Skype, 30 min minutes	
6. Supplier representative 6 (S_6) Sales manager of potential supplier (specific product), Skype, 45 min minutes	
7. Supplier representative 7 (S_7) Sales manager of potential supplier (specific product), Skype, 45 min minutes	
8. Supplier representative 8 (S_8) Sales manager of potential supplier (specific product), in person, 60 min minutes	
9. Technology specialists 1–3 ($TS_{1\text{-}3}$) External product engineers and researcher in the test equipment, in person/Skype, 60 min minutes	

4. Empirical cases

4.1. Case A: sourcing technology as part of existing processes

Supply management within Alfa is a well-recognized and long-established function. The supply management function is included in the production process and, from a development point of view, in top management of the business in general. Alfa has been working with many of its suppliers for decades. From a technical perspective it is often easier to work with old and established suppliers, since the organizations know each other, their respective capabilities, and people. This might, however, result in missing out on important innovations. In the last two years, Alfa has tried to broaden their supply market knowledge. The "supplier selection process" is triggered with the company's decision to develop a new vehicle. Such developments require new suppliers for certain new components or ideas. For new vehicle development, needs arise at the engineering department. The buyers prepare and send Request for Quotations (RFQs) while the engineering group assesses technical aspects of the offers to see if they can reach the set targets.

The specific technology in question is used for testing one of the parts in a newly developed autonomous vehicle. The testing technology can be attached or not attached to the vehicle. The aim is to have the technology integrated in the vehicles so that the final users can also use it. The part for which the testing technology is used, has developed at a high pace, and consists of several different sub-technologies. In contrast to this, the testing technology for the part has been lagging, making testing of the technology complicated.

According to one purchaser at Alfa, only a few companies are offering test equipment with the right features and quality, so supply options are narrow. Today, there are more than 60 suppliers in the market of which 50 were registered during the last couple of years. According to one of the older Tier 1 suppliers to Alfa "*When this market started to grow, [we] decided to enter the market by initiating a partnership with a start-up that had the technical knowledge [we] needed.*" (S_1). The elementary state of the test technology is in general simple. However, the automotive industry requires high product performance since insufficient quality of the test equipment can be harmful to the final car users. In addition, the auto manufacturers require low prices. As a result, the suppliers have aimed for more differentiation, which in turn has resulted in several variations of the test equipment, which are often protected by patents.

Several different factors were making *the supplier selection* for this specific testing technology different from Alfa's usual process. The product's increased technical complexity has resulted in a distorted supplier base. The traditional suppliers that the firm has been working with did not have the knowledge or interest in the product, pushing Alfa to look beyond its supplier base: "*We don't have the technical knowledge that [the start-ups] have*" (S_1). As a result, the technical capability of suppliers has gained more importance than cost in selection of suppliers, which in turn has increased the importance and power of the engineering function in the supplier selection process. Another consequence of the increased importance of technical capabilities is the need to get closer to suppliers and to assess the innovation capability of the suppliers.

Both current and expected regulation changes (e.g., legal, or environmental) in the supply market have also impacted the offerings and thus the supplier selection function. Regulation changes have worked both as constraints and as triggers in changing the nature of the products on the market. A decision recently taken by the national government made it easier for the company to perform tests. This time the decision was beneficial for the testing activities but next time it might be the opposite. It is important for the supplier selection process to understand these regulation changes and to adjust accordingly. The respondents also stated that legal factors are especially important since this is a new technology. Infrastructure is not at a stage to support this technology today, and thus new regulations are expected to be instated.

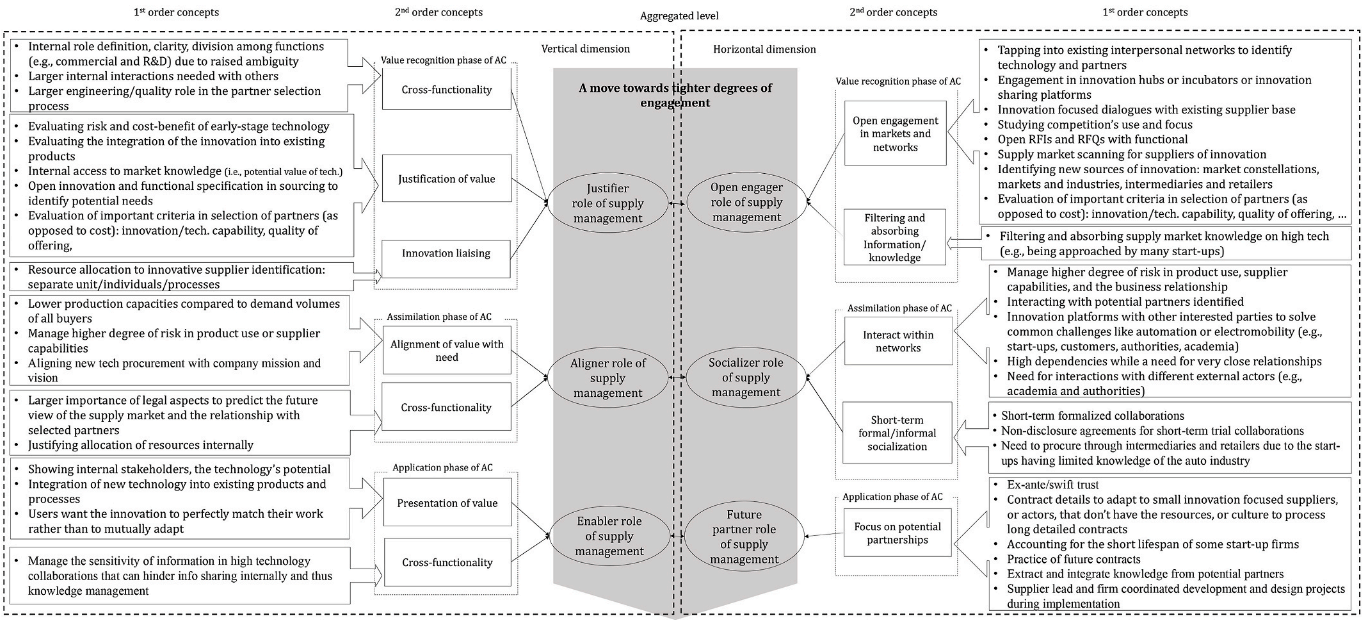


Fig. 2. Frame of analysis of the study.

The purchasers at Alfa stressed that the new entrants in the market have increased the need for them to understand the whole supply market on several different levels (e.g., the new industries and markets, intermediaries and retailers, and mergers and acquisitions). The industry from which the new supplier entrants come, for instance, is considered critical in supplier selection. In addition to knowledge about the supplier in question, gaining understanding of the new industry can lead to identification of other potential suppliers as argued by the interviewees from Alfa.

While Alfa has often thought of the new entrants (such as the start-ups) as the available options, the limited knowledge of these new entrants of the auto industry, or of the specific requirements of a vehicle as the main product, meant Alfa experienced the need to procure the technology through intermediaries or retailers. Due to the same issue of lack of industry/business knowledge, the newcomers have also at times preferred to collaborate with Alfa's old suppliers; that is, the newcomers are responsible for the technical development and the old suppliers contribute with their commercial and industry knowledge. Alfa strongly values procurement from the main source due to the possibility to acquire at lower costs, to build closer relationships and to have better communication channels. Over time, some of these suppliers have also either not survived and exited the market, merged, or been acquired by suppliers from the traditional supplier base of the auto company. Such factors all contribute to a less clear picture of the available supplier options and an increased risk in the relationships.

The increased interest in the product, and the projected future demand, has also triggered some suppliers to invest in production of it. Several suppliers on the market partner with manufacturers that perform the electronic and mechanical assembly of the test equipment. Moreover, some suppliers also partner with companies that offer complementary solutions, like vendors who offer components of the test equipment. Additionally, several of the manufacturers are entering partnerships with the new supplier types, partly to have a larger control in the design and engineering of the technology to better integrate them in their vehicles. The start-ups also value different sorts of financial support from the sectors: "… *[other]* financial support *for example by promising to buy a specific order batch when the product is launched or initiating a partnership to develop the product together*" (S_3). There are also instances of auto firms deciding to produce the test equipment in-house. The importance of understanding the supply network in supplier selection was further emphasized by the fact that the technological changes are both captured and triggered by other competitor manufacturers. Analyzing the competitors can help understand the potential technology changes, but also the interest in a specific technology which can help project the future of the supply market and the way a relationship is built with a chosen supplier.

4.2. Case B: sourcing technology through separate processes

The supply management function at Beta has been centralized in an independent department reporting directly to top management. They have been working with many of their suppliers for decades. The purchasers at Beta expect the supply and demand market they deal with to change even more in the future, forcing the company to change ways of thinking and working. Consequently, Beta has experienced a need to revisit their processes for acquiring market knowledge. Scanning the markets for new innovative suppliers poses different challenges compared to finding the most competitive suppliers for traditional, mature components. A main conflict between the two types of supply management activity is the importance of cost or price reductions. For the innovative suppliers, the purchasers need to maintain a generic level of market knowledge and stay updated to adapt to the coming changes in the market. The segment leader thought simultaneous conversations with several suppliers and start-ups are vital to keep the market knowledge generic at the technology entry stage. On the other hand, today, Beta is approached by many suppliers of high technology and at times finds it challenging to filter or absorb the available information. One procurement manager state that they do not scan the supply market for new potential suppliers that much, since often the suppliers approach the firm. Another procurement manager added that having a large network has helped the team a lot when scanning the market.

As a direct response to the pace of change in the supply market of technology, the company has developed an independent platform (like an innovation hub), which is their "*global arena for technology and business transformation*" (IP_1). Here, external parties (including customers, suppliers, start-ups, authorities, and academia) are invited to collaborate with Beta to, among other things, solve common challenges such as automation, electromobility and connectivity. A few years ago, Beta also developed an independent "innovative procurement" group which is tasked with identifying market innovation (in terms of products, services, ideas, or collaboration) and integrating them within the other procurement categories. This group consists of 10–20 individuals, with the head responding directly to the CPO. The group works a lot with collaboration with potential and relevant actors including academia, innovation centers, suppliers, and internal actors, to both identify and trigger innovation.

Early phase technologies, such as those for automation, electromobility and electrical components are not easily measured in terms of risk and benefits, especially monetary. One of the biggest challenges is the limited experience with the new technologies: "*We haven't had any buyers who have worked with [*e.g.*, blockchain or machine learning] for 10–15 years, we hardly know what it is*" (IP_2). This limited experience makes the task about understanding and communicating how "*to transform these early phases into potential value for the company in the future*" (IP_3).

In the electromobility and innovative procurement segments, an important aspect of sourcing early phase technology and potential suppliers, is showing the potential and technical progress that the company can later build on. This way of thinking about projects is considered different from the traditional mindset of a procurement department, which is much more cost focused. Historically, convincing stakeholders and top management has been about costs and profit estimates, which is a challenge for innovative technology due to the limited possibilities for benchmarking. In this respect, a project manager believed that new ways of thinking need to be implemented in the firm for it to become a leader in technological change. Both the segment manager and the procurement manager found it difficult to convince internal stakeholders to start early phase projects.

Beta has practiced a variety of methods to increase their market knowledge and introduce new ideas today, such as engagement with external research, academia, innovation hubs, and the use of their existing networks. In relation to a specific early phase technology project that Beta is currently sourcing for, an involved procurement manager pointed out that most individuals at the department were aware of the technology but had little actual knowledge. Through an initiated project, the technology was further investigated, and they found their competitors engaged in similar investigations. Consequently, more resources were allocated to larger investigations and external projects were initiated to evaluate the potential usage areas of this technology for the company.

According to a manager, RFIs and RFQs need to become more outcome-oriented with fewer specifications and more general level requirements when sourcing for innovative technology. A segment leader gives an example from a prior sourcing situation, where they had to send out a low detailed RFI to understand their own needs and to receive feedback on what the market was capable of supplying. An engineer also contends that when they were writing the technical requirements they did not know if the requirements were too high or too low since they had no previous RFI to compare with. One of the directors adds that with new technology, such as blockchain, you do not yet know the future use-case of the technology.

Innovation hubs, incubators, and similar set-ups have enabled access to, and engagement with, ideas and pilots and have been a good source of input for further research and projects for the firm. They have also brought new people into the company. This enables the firm to collaborate with start-ups for a limited period for both parties to get to know each other. These time-limited projects are often around 2 months long, have a clear start and stop process, and are bound by NDA agreements. Beta has found these types of relationships positive as they could not know in advance if they would like to work with the smaller firms.

Another source of market information has been what they call "Supplier Innovation Dialogues", through which the innovative procurement group invites between 5 and 10 suppliers for a 3-hthree-hour meeting to discuss innovation. Every supplier meets Beta's CPO, executive board, relevant buyers, and engineers. These meetings are set-up as frequently as every month. Beta considers collaboration with the existing suppliers to be easier than with new firms. While these events are appreciated, as one procurement manager notes, it could "*be beneficial to conduct [them] in markets where [my] team has less information about the supply market*" (P_2).

Most internal decision makers, including the lawyer, noted how the relationship with suppliers for such innovative inputs is riskier than their relationship with other suppliers. Two of the engineers said that when sourcing for more innovative suppliers you are sometimes forced to scan for suppliers that have no, or very little, prior experience of delivering to the automotive industry. They noted that the suppliers outside the automotive industry are not used to all the development phases that are standard in that industry. According to a segment leader when engaging with start-ups: "*The challenging part in the early discussion is to get them aware of our [vehicle] requirements*" (P_3). The interviewee says that this takes a lot of time from Beta both in communicating the requirements but also in making sure that the supplier understands them.

Contracts are a main risk management tool in such engagements. According to a buyer the traditional contract covers "*basically every possible risk*" (P_2), making the buyers overuse them to "*hedge them against unknown risks*". This is especially true when sourcing for innovative technology since the buyers have limited technical expertise. However, the one-size-fits-all template contracts that are mainly used today, can't easily be adapted to small innovative suppliers. A lawyer thought the contracts should be more streamlined for small suppliers, as he thought it unreasonable to draft all scenarios into all contracts. Small suppliers don't always have the capacity to review all the contracts. An engineer explained that beside the standard contract there is also a 'technical requirement' contract that for a small supplier this implies a lot of additional work. This means, according to the engineer, that small suppliers tend not to respond to the RFI or RFQ. If the contracts and requirements are too extensive, Beta then risks missing the engagement of some small suppliers.

5. Findings and discussions

The findings from the two cases show that the case firms dealt with a wide range of challenges regarding supply management of future technologies related to autonomous drive, electromobility and connectivity (see the appendix for a summary of the cross-case data). The firms were assessing and selecting suppliers that were new to them as well as new to the automotive industry. Here, procurement, in collaboration with R&D, had a vital role in scanning the market and assessing suppliers, as well as establishing relationships with potential suppliers. Our study, thus, confirms previous studies pointing to the need for cross-functional collaboration when sourcing innovation (Calvi et al., 2018; Patrucco et al., 2022). However, we made additional observations about the nuances of this cross-functional collaboration that we will elaborate on below.

Building on the conceptualization of AC, with its three stages of identification, assimilation, and application/integration, we organized our data accordingly (see Figs. 3 and 4). In these phases, firms focus both on organizing internally (in the transfer of knowledge between individuals and the firm) as well as externally (in the transfer of knowledge between the sourcing environments and the firm); i.e. both horizontally and vertically as discussed in the AC literature (Martinkenaite & Breunig, 2016).

5.1. Vertical dimension of AC for supplier selection for high technology

Vertically, in the interaction between the individuals and the firm, we found a high degree of cross-functional teamwork at all three AC phases of sourcing high technology. While this is very much in line with previous findings in the literature connected to how firms organize to manage high technological uncertainties (e.g. Melander & Lakemond, 2015), we observed that the nature of such cross-functional work, and

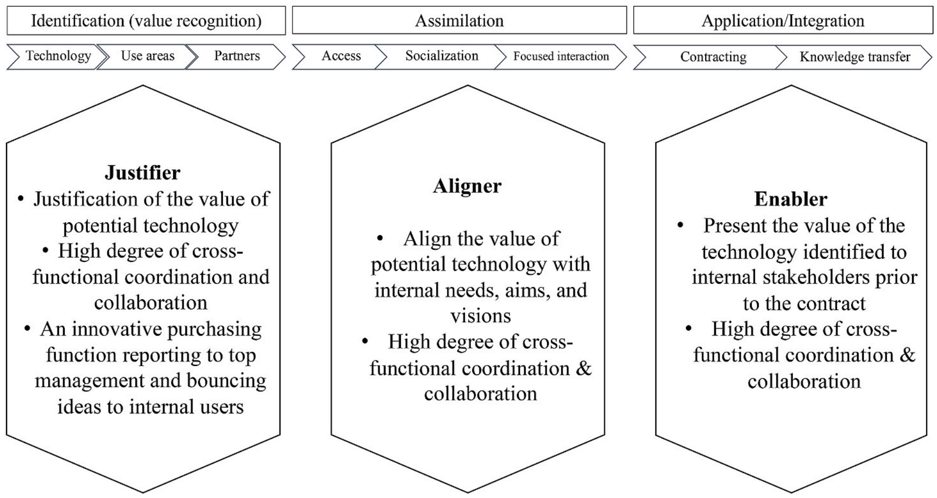


Fig. 3. Vertical organization of supplier selection for high technology across AC phases.

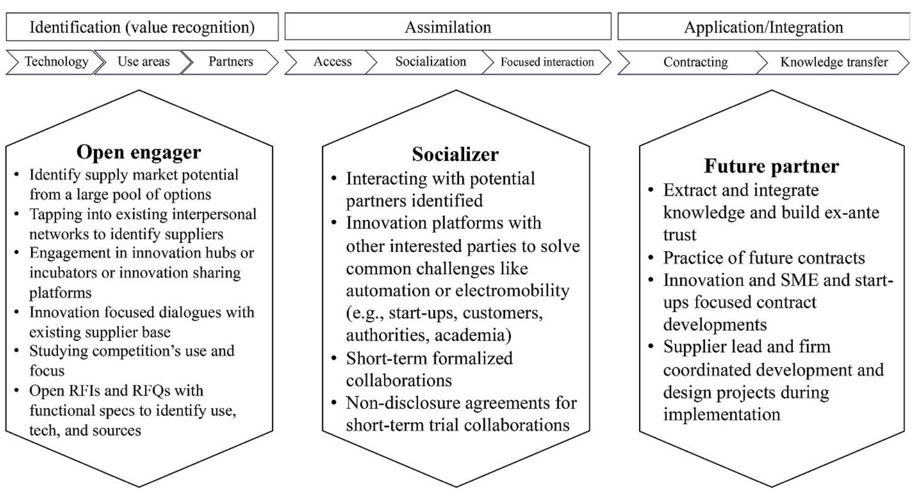


Fig. 4. Horizontal organization of supplier selection for high technology across AC phases.

thus, the role of supply management in the cross-functional team, changes as the process moves from identification to assimilation and integration before the contractual relationship begins; as summarized in Fig. 3.

Our data suggests that in the identification phase (i.e., on the left side of the figure), supply management takes a *justifier* role for the potential technology with a value recognition aim in mind. While scanning markets for the technology itself and the suitable suppliers, supply management needs to be in close contact with the potential internal users and management to be able to recognize the potential value. Calvi et al. (2018) argues that if supply management can develop AC, then it will be well suited to collaborate with functions such as R&D, particularly for market scanning of new technologies and their suppliers. In addition to cross-functional work, we found that during the identification phase, one way to organize is to create a separate innovative supply management group at the company level that can take such a role. This is similar to Schiele's (2010) and Stek and Schiele's (2021) suggestion of "advanced sourcing" for innovation in general. Our findings, extend this suggestion to show the relevance of such a function, especially, in the early market scanning parts of supplier selection. This gets resources and attention to the importance of market scanning for new technologies and new suppliers of potential technologies and to address the conflicting needs of supply management of innovation compared to other supply management situations.

The need for high degrees of internal cross-functional interactions persists during assimilation (and even integration), but here supply management first takes an *aligner* role to align the recognized value with internal needs, aims, and visions (i.e., the middle part of the figure). As the firm approaches contracting (i.e., the right side of the figure), with the need to integrate and transfer the needed knowledge to the internal stakeholders to prepare them to both enter a contractual relationship and to ensure needed input into the contracts, supply management takes an *enabler* role to show the potentials of the technology and values recognized to the right internal actors.

Similar to previous research on supply management's involvement when firms source technologies, we find cross-functional collaboration, mainly between procurement and R&D (Brattström and Richtnér 2014; Melander & Lakemond, 2015). We find that although there is collaboration between functions, this is not without friction. While previous research points towards the differing goals, wants and requirements of the functions as a source of conflict (Brewer et al., 2019; Franke & Foerstl, 2020a) we found tensions to also be due to the new supplier selection situation having differing and at times conflicting requirements compared to the cross-functional teams' usual process. Often, these are related to different views of how suppliers should be assessed, where supply management on the one hand is required to put emphasis on cost, while on the other hand R&D focuses on the technology itself and its potential.

This conflict of interests is not necessarily bad, as Brattström, and Richtnér (2014) Anders (2014) show: by clearly separating R&D and procurement when dealing with suppliers, procurement can handle negotiations and contractual issues, while R&D handles technological discussions, allowing the firm to both maintain an atmosphere of collaboration and avoid appropriations. However, while separating these functions in dealing with suppliers clearly has its benefits, our study shows that collaboration internally when assessing suppliers and their technologies is necessary in assimilating and transferring knowledge. In these supplier selection processes, both technologies and supplier capabilities need to be evaluated. In addition, the potential of the development of technologies and the potential of development of supplier capabilities also need to be evaluated.

5.2. Horizontal dimension of AC for supplier selection for high technology

Horizontally, in the interaction of the firm with its external environment, the supplier selection process moves from market scanning to more focused interactions to transfer the knowledge from the selected few that enter the contracting round. As summarized in Fig. 4 from the left to the right side, initially, during the identification phase, supply management is organized to be an *open engager*, to identify and scan as openly as possible. Inter-personal networks of individuals seem to be an important source of information for scanning the markets. In their efforts to become more open towards new technologies and suppliers, firms have developed more open RFIs and RFQs, that focus more on functionality, rather than detailed technical specifications. Interestingly, it seems that firms move towards including elements in common with how SMEs and start-ups are conducting their supplier selection process, making it a more dynamic and intuitive process (Ellegaard et al., 2022; La Rocca & Snehota, 2021). Here, we found that firms take a large supply network perspective to identify supply market potential. In addition, firms are engaged in innovation focused dialogues with their existing suppliers. However, to reach new market entrants such as start-ups, firms engage in innovation hubs, incubators and platforms designed for sharing innovation.

Externally, during assimilation, supply management becomes a *socializer*, interacting with the potential partners and suppliers identified in different settings. To be able to explore new technologies, supply management can organize short-term formalized collaborations with new entrants which create trust during that short period, to access new knowledge and get to know these new suppliers (such as engaging in short term contracts within incubation hubs). In these collaborations, a combination of trust and contracts is used, where non-disclosure agreements are made for these short-term trials. Innovation platforms are used as mediums for gathering information on other interesting parties that may influence, e.g., the development of the transport system, its technologies, and regulations. Here, actors such as manufacturers, start-ups, customers, governmental agencies, and academic representatives discuss innovative solutions.

During integration, supply management needs to move towards being more of a *future partner* to extract and integrate the related knowledge. Here the firm needs to at times take a leap of faith (Mikkelsen Ole & Johnsen Thomas, 2019) and develop an ex-ante trust (Arvidsson & Melander, 2020; Agndal et al., 2023). This finding is in line with the work by Wagner (2012) on NPD, contending that firm boundaries should be open to suppliers during the initial phases of NPD to benefit from collaborating with suppliers through interorganizational knowledge sharing. Our study suggests that the same contentions are valid for the pre-contractual phase of supplier selection and market scanning for high technology. Firms should also focus on understanding the nature of new partners in for instance, developing new forms of contract suitable for the innovation context. The firms in our study, viewed these contract developments, where new contracts are tested and evaluated, as useful practice for future. Firms can take a coordination role and let these new actors lead the design of the project during implementation. By organizing this way, the buying firms enable these new actors to continue being creative and innovative, without being hampered by the buying firms' existing structures and project management protocols.

6. Conclusions and contributions

In this paper, our aim was to provide insights into how firms can configure their capabilities and resources to better identify, access, and capitalize on viable innovation in the high technology supply market during the pre-contractual phase of relationships. Based on our empirical observations and findings, we propose a framework for supplier selection for high technology innovation (see Fig. 5). The framework illustrates the process from the identification of technology and potential partners to the assimilation and integration of high technology knowledge in supplier contracts. It emphasizes the progression from loose engagement to tighter interactions within the firm and with the supply market. The framework also highlights the roles of supply management, which evolve from justification to alignment and enabling. Moreover, we confirm earlier findings regarding the range of sources for innovation in the automotive industry, from traditional supply bases to start-ups.

The engagement discussed in this context takes place both between individuals and in between groups and functions (similar to findings of e.g., Arvidsson et al. (2022)). The line on the left side of the figure shows the large number of options in the supply market compared to shorter line on the right side depicting the selected few suppliers selected to sign agreements with. Building on the work of Martinkenaite and Breunig (2016) discussing the interplay between the outside and inside environment of the firm, the dark arrows in the middle of the figure, indicate the constant link between the knowledge gained from the supply market (i.e., outside) and within the firm (e.g., across the functions). The changes in the level of engagement from identification to integration (i.e., from the left side of the framework to the right), create different roles for supply management (extending the work by scholars such as Ellram Lisa, Tate, and Choi Thomas (2020) who identify a confusion in the role of supply management when sourcing innovation). Similar to the findings of, e.g., Ateş et al. (2018), we found that internally, high levels of cross-functionality in needed throughout the sourcing process. The role of supply management moves from more of a justification role in recognizing and communicating the value (i.e., Justifier) to aligning the internal needs and wishes to the potentials in the market (i.e., Aligner), to being an enabler in integration of the knowledge from the technology (i.e., Enabler). Externally, on the other hand, supply management needs to move from being very open in identifying potentials (i.e., Open engager), to moving towards more focused socialization (i.e., Socializer) and interacting with the identified few as potential future partners (i.e., Future partners). In this respect, finally, we confirm earlier findings from the automotive industry by Servajean-Hilst and Calvi (2018), who point out that sources for innovation range from traditional supply base to start-ups.

6.1. Theoretical contributions

Our study contributes to the existing literature (e.g., discussions by Calvi et al. (2018) and Schiele (2010) on the need for evolution of supply management to capture innovation) by providing practical insights into how supply management practices can evolve to capture disruptive high technology innovation. Our findings, *first and foremost*, add to this discussion by showing that supply management can move from looser to tighter interactions vertically within the borders of the firms and horizontally with the outside market to identify, assimilate, and integrate the high technology during the pre-contractual phase of supplier selection (Stek and Schiele, 2021). We extend previous discussions on assimilation prior to acquisition by showing how this can be achieved in practice, emphasizing the importance of informal approaches alongside

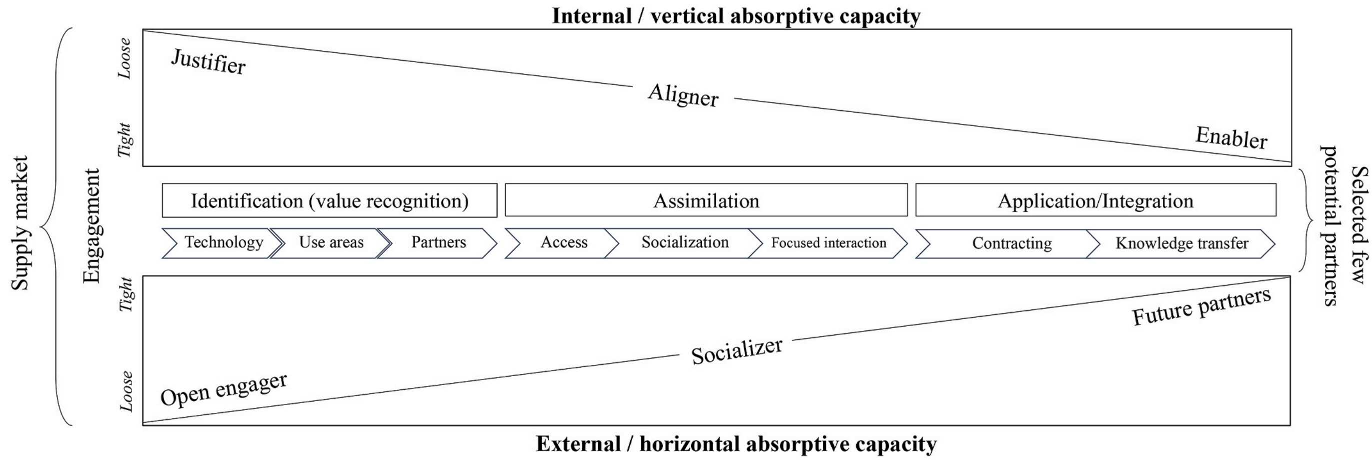


Fig. 5. An Absorptive Capacity framework for organizing supplier selection for high technology innovation.

formal and structured ones. Additionally, we highlight the duality or multiplicity of the supply management role in sourcing innovation (e.g., Mikkelsen Ole & Johnsen Thomas, 2019; Ellram Lisa et al., 2020), discussing the shift from justification to alignment and enabling, and addressing the differing requirements from the purchaser.

Furthermore, our findings contribute to the understanding of supplier selection from start-ups (Homfeldt et al., 2017). We elaborate on the need for distinct supplier selection processes tailored to the particularities of start-ups, including identification tools, evaluation criteria, and collaboration approaches (Kurpjuweit et al., 2021). We emphasize the importance of open socialization with market innovators, short-term structures for intensive socialization, and measures such as future contracts and joint development projects for successful integration and adaptation of technology. We also highlight the significance of cross-functional coordination and collaboration for integrating external knowledge in the later phases of supplier selection.

Lastly, by applying the absorptive capacity framework to the context of supplier selection for high technology, our study extends previous discussions on the role of supply management (Duan et al., 2021; Homfeldt et al., 2017). We show that supply management's role goes beyond market analysis and cost justification, encompassing assimilation, integration, and knowledge transfer. Supply management plays a crucial role in scouting for new and existing suppliers and technologies, coordinating cross-functional collaborations internally (adding to Driedonks et al., 2014), and socializing and engaging externally.

6.2. *Managerial implications*

The findings of our study demonstrate how large firms with established procurement structures can effectively manage the supply of innovation in highly uncertain technological contexts. One approach is to create a dedicated innovation group that focuses on market scanning for new technologies, engages with innovation hubs, and coordinates with start-ups in innovation platforms. This builds on Schiele's (2010) concept of "advanced sourcing" and emphasizes the importance of relational aspects in supply management, as suggested by Goldberg and Schiele (2020). Hence, OEMs aiming to supply from innovative start-ups need to adjust their processes to facilitate the integration of start-ups to their supply base. Moreover, we suggest that managers consider broadening their collaboration base to include more actors in their search for new technologies. These actors could include existing suppliers, start-ups, governmental agencies, public organizations, customers, and academic representatives forming a network of collaborators. In the context of the automotive industry, where many changes are happening simultaneously (connectivity, autonomous drive and electromobility) there is a need for a system perspective as well as an awareness of future regulations and requirements (Monios and Bergqvist 2020). Hence, a broad base for discussing innovation and future transport solutions is needed. In relation to electromobility and autonomous drive, such discussions should include established OEMs, innovative start-ups as well as public organizations. Finally, our study also shows the need for supply management to understand the supply market on multiple levels, such as new industries and markets, intermediaries and retailers, and mergers and acquisitions. As transport becomes more connected, electrified, and autonomous, multiple actors need to collaborate and share information in the transport network. By opening to new actors in the supply phase, OEMs are moving towards a more diverse network in their development of new innovative products.

6.3. *Limitations and future research*

Our study is limited by our choice of a dual qualitative case study. The choice of method has enabled an in-depth understanding (Eisenhardt Kathleen, 2021) of the organizing of supply management of innovation. We also have more data on case A than case B, where we were able to access more representatives to interview in case A. Future research could be of a longitudinal nature to follow-up on the outcomes of the selection of innovative suppliers. We also call for more studies with other potential approaches in sourcing of technology to test our proposed framework and findings. A fruitful venue for future studies could be to apply the research world café methodology (Schiele et al. 2022), to test and discuss our findings among industrial experts.

As the supply management of high technology is affecting many industries and similar challenges are experienced in other industries, another research venue would be to explore how firms in other such industries organize for the supply management of innovation. Moreover, it would be interesting to investigate what consequences a separate group of supply management for innovation has on the overall organization. Another suggestion for future research is to compare firms that procure innovative high technology from suppliers regularly with those that do so, infrequently.

Finally, out study is limited to the AC during the supplier selection process and excludes the post-contractual relationship. Future studies, should investigate the capabilities needed to identify, assimilate, and integrate supplier's radical innovation post-contract.

Appendix A. Data collection guides (Primary and secondary sources)

Buyers

General information

- Individual and firm background
- Product/commodity/technology information
- Supply market characteristics and market trends similar to questions to the suppliers.

Information Gathering on the technology/suppliers

- The process of gathering information about the technology, supply market and suppliers including information sources
- Process for searching for new suppliers inside the current supplier base compared to searching for completely new suppliers
- Market scanning processes
- Use internal IT systems or databases to search for information
- Needed knowledge to find relevant information about suppliers and technology
- Role of experience and training
- Collaboration with other departments regarding scanning the supply market
- Challenges

Information processing and sharing on the technology/suppliers

- Storing and transfer of information about the technology and suppliers
- Processing and analyzing of the gathered information?
- Routines of spreading gathered information with relevant colleagues
- Access and use of information gathered by others
- Challenges of processing, storing, and retrieving gathered information

Suppliers

General information

- Individual and firm background
- Product/commodity information
- Supply market characteristics

Company background:

- When was your company founded?
- When did you produce your first product?
- How many employees are currently employed at your company?
- How many units of the equipment do you produce each year?
- Which are the shareholders of your company?
- In what industries are your customers?
- In what industry did you start to sell your products?
- What companies are your main customers?
- What differentiate your products from competitors' products?
- How many patents does your company have?

Specific technology information including testing and adjustments to target the car manufacturers (specific to one of the cases)

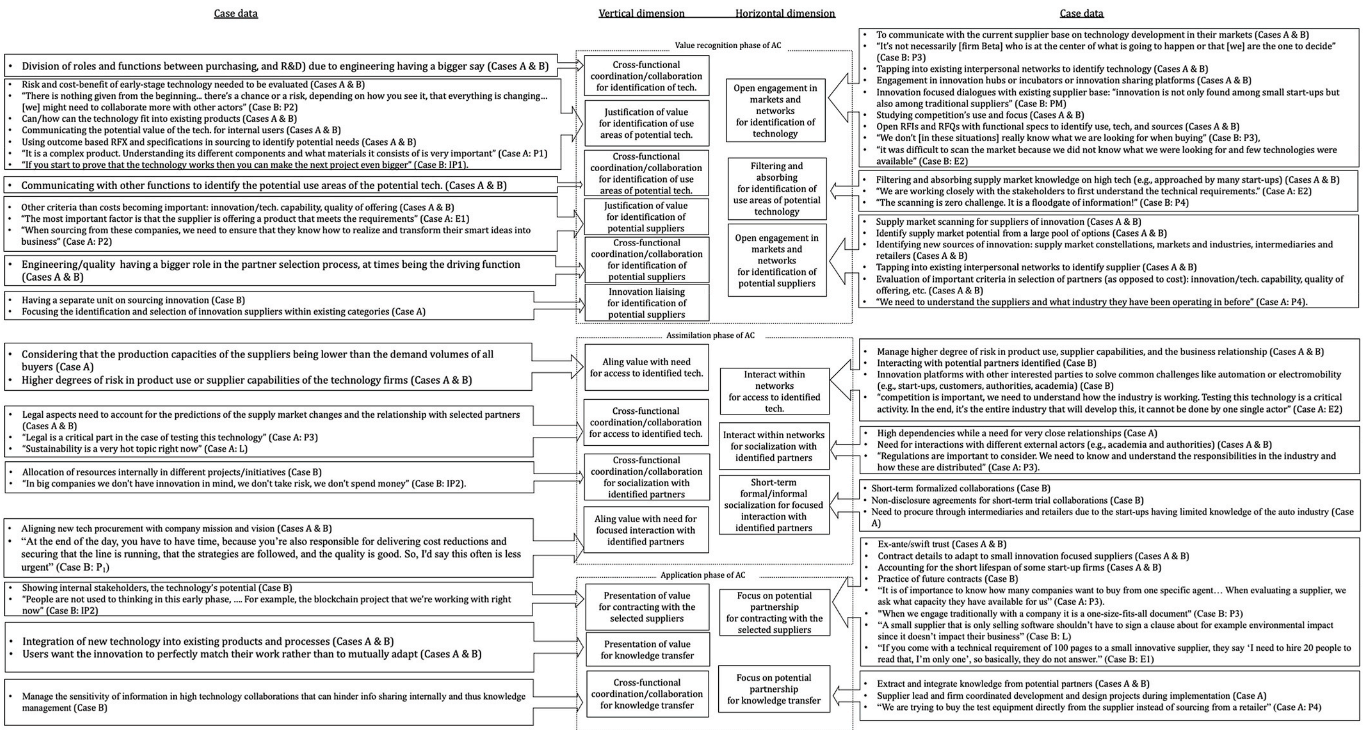
- Product trends and commercial trends
- Challenge for this market
- The balance between supply and demand
- Other companies producing similar products
- New companies entering the market the recent years
- Entry barriers for a new actor
- Regulations or environmental factors that can affect the developments.

Secondary sources

Secondary data was collected to triangulate the interview data, and to understand the supply market of the innovative technology. Market reports, news articles, company websites and video-recordings were used.

- •*Market reports* written by consultancy firms and industry experts have been investigated to see what already is stated about the supply markets of the technologies for case A and B.
- •News articles. Since these markets are rapidly changing, news articles helped to find information about suppliers, such as new investments, acquisition or launches of products.
- *Company websites (*firms A and B and innovative technology suppliers). To get more details on the firms, the company websites and video-recordings of interviews with CEOs of the companies have been studied.
- *Internal documents* regarding how a supply market analysis should be structured according to firms A and B were also studied.

Appendix B. The cross-case data on the vertical and horizontal dimensions of the different AC phases



References

Agndal, H., Arvidsson, A., & Nilsson, U. (2023). Managing appropriation concerns and coordination costs in complex vendor relationships: Integration and isolation as governance strategies. *Industrial Marketing Management, 113*, 116–127.

Arvidsson, A., Lisa, M., & Henrik, A. (2022). Social cross-functional vendor selection in technologically uncertain sourcing situations. *Journal of Engineering and Technology Management, 65*, Article 101696.

Arvidsson, A. P., & Melander, L. (2020). The multiple levels of trust when selecting suppliers–Insights from an automobile manufacturer. *Industrial Marketing Management, 87*, 138–149.

Ateş, M. A., van Raaij Erik, M., & Finn, W. (2018). The impact of purchasing strategy-structure (mis) fit on purchasing cost and innovation performance. *Journal of Purchasing and Supply Management, 24*(1), 68–82.

Bals, L., Heike, S., Kelly, S., & Klaas, S. (2019). Purchasing and supply management (PSM) competencies: Current and future requirements. *Journal of Purchasing and Supply Management, 25*(5), Article 100572.

Bessant, J., Richard, L., Hannah, N., & Phillips, W. (2005). Managing innovation beyond the steady state. *Technovation, 25*(12), 1366–1376.

Bonab, S. R., Gholamreza, H., Hamed, R., Jafarzadeh, G. S., Mostafa, H.-K., & Hana, T. (2023). Sustainable resilient supplier selection for IoT implementation based on the integrated BWM and TRUST under spherical fuzzy sets. *Decision making: Applications in Management and Engineering, 6*(1), 153–185.

Brattström, A., & Anders, R. (2014). Good cop–bad cop: Trust, control, and the lure of integration. *Journal of Product Innovation Management, 31*(3), 584–598.

Brewer, B., Bryan, A., & Wallin, B. C. (2019). Cross-functional influence and the supplier selection decision in competitive environments: Who makes the call? *Journal of Business Logistics, 40*(2), 105–125.

Bryman, A., & Bell, E. (2007). *Business research methods*. USA: Oxford University Press.

Bstieler, L. (2006). Trust formation in collaborative new product development. *Journal of Product Innovation Management, 23*(1), 56–72.

Calvi, R., Thomas, J., & Picaud, B. K. (2018). Purchasing involvement in discontinuous innovation: An emerging research agenda. In A. Carrizo Moreira, L. M. Ferreira, & R. A. Zimmermann (Eds.), *Innovation and supply chain management: Relationship, collaboration and strategies* (pp. 165–185). Springer.

Camisón, C., & Forés, B. (2010). Knowledge absorptive capacity: New insights for its conceptualization and measurement. *Journal of Business Research, 63*(7), 707–715.

Choi, T. Y., & Hartley, J. L. (1996). An exploration of supplier selection practices across the supply chain. *Journal of Operations Management, 14*(4), 333–343.

Cohen Wesley, M., & Levinthal Daniel, A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128–152.

Cousins, P. D., Handfield, R. B., Lawson, B., & Petersen, K. J. (2006). Creating supply chain relational capital: The impact of formal and informal socialization processes. *Journal of Operations Management, 24*(6), 851–863.

Cousins Paul, D., Lawson, B., Petersen Kenneth, J., & Handfield Robert, B. (2011). Breakthrough scanning, supplier knowledge exchange, and new product development performance. *Journal of Product Innovation Management, 28*(6), 930–942.

Di Stefano, G., Alfonso, G., & Gianmario, V. (2012). Technology push and demand pull perspectives in innovation studies: Current findings and future research directions. *Research Policy, 41*(8), 1283–1295.

Driedonks Boudewijn, A., Gevers Josette, M. P., & van Weele Arjan, J. (2014). Success factors for sourcing teams: How to foster sourcing team effectiveness. *European Management Journal, 32*(2), 288–304.

Duan, Y., Huang, L., Luo, X., Cheng, T. C. E., & Liu, H. (2021). The moderating effect of absorptive capacity on the technology search and innovation quality relationship in high-tech manufacturing firms. *Journal of Engineering and Technology Management, 62*, Article 101656.

Easterby-Smith, M., Manuel, G., Elena, A., & Jason, F. (2008). Absorptive capacity: A process perspective. *Management Learning, 39*(5), 483–501.

Easton, G. (2010). Case study research. A critical realistic approach. *Industrial Marketing Management, 39*(1), 118–128.

Eisenhardt, T. (1995). Accelerating adaptive processes: Product innovation in the global computer industry. *Administrative Science Quarterly, 40*(1), 84–110.
Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal, 50*(1), 25–32.
Eisenhardt Kathleen, M. (2021). What is the Eisenhardt Method, really? *Strategic Organization, 19*(1), 147–160.
Ellegaard, C., Ulla, N., & Nina, L. (2022). Intuitive global sourcing – a study of supplier selection decisions by apparel SMEs. *International Journal of Operations & Production Management*. ahead-of-print (ahead-of-print).
Ellram, L. M. (1990). The supplier selection decision in strategic partnerships. *Journal of Purchasing & Materials Management, 26*(4), 8–14.
Ellram, L. M. (1996). The use of the case study method in logistics research. *Journal of Business, 17*(2), 93–137.
Ellram Lisa, M., Tate, W. L., & Choi Thomas, Y. (2020). The conflicted role of purchasing in new product development costing. *Journal of Supply Chain Management, 56*(1), 3–32.
Finger, A. B., Flynn, B. B., & Paiva, E. L. (2014). Anticipation of new technologies: Supply chain antecedents and competitive performance. *International Journal of Operations & Production Management, 34*(6), 807–828.
Flor, M. L., Cooper Sarah, Y., & Oltra María, J. (2018). External knowledge search, absorptive capacity and radical innovation in high-technology firms. *European Management Journal, 36*(2), 183–194.
Franke, H., & Foerstl, K. (2020a). Goals, conflict, politics, and performance of cross-functional sourcing teams—results from a social team experiment. *Journal of Business Logistics, 41*(1), 6–30.
Franke, H., & Foerstl, K. (2020b). Understanding politics in PSM teams: A cross-disciplinary review and future research agenda. *Journal of Purchasing and Supply Management*, Article 100608.
Fundin, A., & Elg, M. (2006). Exploring routes of dissatisfaction feedback. *International Journal of Quality & Reliability Management*.
Gebauer, H., Hagen, W., & Bernhard, T. (2012). Absorptive capacity, learning processes and combinative capabilities as determinants of strategic innovation. *European Management Journal, 30*(1), 57–73.
Gioia Dennis, A., Corley Kevin, G., & Hamilton Aimee, L. (2013). Seeking qualitative rigor in inductive research notes on the Gioia methodology. *Organizational Research Methods, 16*(1), 15–31.
Goldberg, J., & Schiele, H. (2018). Early supplier integration: Assessing supplier innovation ideas. *IEEE Engineering Management Review, 46*(3), 94–102.
Goldberg, J. M., & Schiele, H. (2020). Innovating with dominant suppliers: Lessons from the race for laser light. *International Journal of Innovation Management, 24*(1), Article 2050008.
Homfeldt, F., Alexandra, R., Hanno, B., Daniel, B., & Fabio, S. T. (2017). Identification and generation of innovative ideas in the procurement of the automotive industry: The case of Audi AG. *International Journal of Innovation Management, 21*(7), Article 1750053.
Hurmelinna-Laukkanen, P., Heidi, O., Kirsimarja, B., & Victoria, P. (2012). Orchestrating R&D networks: Absorptive capacity, network stability, and innovation appropriability. *European Management Journal, 30*(6), 552–563.
Jones, J., & Barner, K. (2015). *Supply market intelligence for procurement professionals: Research, process, and resources*. J. Ross Publishing.
Khraishi, A., Antony, P., Fahian, H., & Chandrasekararao, S. (2023). Knowledge management in offshoring innovation by SMEs: Role of internal knowledge creation capability, absorptive capacity and formal knowledge-sharing routines. *Supply Chain Management: International Journal, 28*(2), 405–422.
Kim, B., Kim, E., & Foss, N. J. (2016). Balancing absorptive capacity and inbound open innovation for sustained innovative performance: An attention-based view. *European Management Journal, 34*(1), 80–90.
Kompalla, A., Michael, S., Andreas, B., & Gabriela, T. (2016). *Agile business strategies: How to adjust to rapidly changing environments?*.
Kurpjuweit, S., Wagner, S. M., & Choi Thomas, Y. (2021). Selecting startups as suppliers: A typology of supplier selection archetypes. *Journal of Supply Chain Management, 57* (3), 25–49.
La Rocca, A., & Snehota, I. (2021). Mobilizing suppliers when starting up a new business venture. *Industrial Marketing Management, 93*, 401–412.
Lichtenthaler, U. (2016). Determinants of absorptive capacity: The value of technology and market orientation for external knowledge acquisition. *Journal of Business & Industrial Marketing, 31*(5), 600–610.
Luthra, S., Kannan, G., Kannan, D., Kumar, M. S., & Garg, C. P. (2017). An integrated framework for sustainable supplier selection and evaluation in supply chains. *Journal of Cleaner Production, 140*, 1686–1698.
Luzzini, D., Amann, M., Federico, C., Michael, E., & Stefano, R. (2015). The path of innovation: Purchasing and supplier involvement into new product development. *Industrial Marketing Management, 47*, 109–120.
Luzzini, D., & Ronchi, S. (2011). Organizing the purchasing department for innovation. *Operations Management Research, 4*(1), 14–27.
Martinkenaite, I., & Breunig, K. J. (2016). The emergence of absorptive capacity through micro–macro level interactions. *Journal of Business Research, 69*(2), 700–708.
Melander, L., & Arvidsson V. (2022). Green innovation networks: A research agenda. *Journal of Cleaner Production, 357*, Article 131926.
Melander, L., & Lakemond, N. (2015). Governance of supplier collaboration in technologically uncertain NPD projects. *Industrial Marketing Management, 49* (August), 116–127.
Melander, L., & Tell, F. (2014). Uncertainty in collaborative NPD: Effects on the selection of technology and supplier. *Journal of Engineering and Technology Management, 31* (January-March), 103–119.
Meqdadi, O., Johnsen Thomas, E., Johnsen Rhona, E., & Asta, S. (2020). Monitoring and mentoring strategies for diffusing sustainability in supply networks. *Supply Chain Management: International Journal, 25*(6), 729–746.
Mikkelsen Ole, S., & Johnsen Thomas, E. (2019). Purchasing involvement in technologically uncertain new product development projects: Challenges and implications. *Journal of Purchasing and Supply Management, 25*(3), Article 100496.
Monios, J., & Bergqvist R. Logistics and the networked society. (2020). A conceptual framework for smart network business models using electric autonomous vehicles (EAVs). *Technological Forecasting and Social Change, 151*, Article 119824.
Patrucco, A., Federico, F., & Anthony, Di B. (2022). Characteristics of supplier performance measurement systems in collaborative innovation projects: The role of the purchasing department. *Supply Chain Management: International Journal, 27*(2), 207–231.
Patterson, W., & Ambrosini, V. (2015). Configuring absorptive capacity as a key process for research intensive firms. *Technovation, 36*, 77–89.
Petersen, K. J., Handfield, R. B., & Ragatz, G. L. (2005). Supplier integration into new product development: Coordinating product, process and supply chain design. *Journal of Operations Management, 23*(3–4), 371–388.
Picaud-Bello, K., Thomas, J., Calvi, R., & Mihalis, G. (2019). Exploring early purchasing involvement in discontinuous innovation: A dynamic capability perspective. *Journal of Purchasing and Supply Management, 25*(4), Article 100555.
Picaud-Bello, K., Thomas, J., & Richard, C. (2022). Purchasing involvement in new product development: An absorptive capacity perspective. *Industrial Marketing Management, 104*, 150–166.
Pihlajamaa, M., Riikka, K., Julius, S., & Kari, T. (2017). Can supplier innovations substitute for internal R&D? A multiple case study from an absorptive capacity perspective. *Journal of Purchasing and Supply Management, 23*(4), 242–255.
Prior, D. D., Joona, K., & Sami, K. (2018). Sensemaking, sensegiving and absorptive capacity in complex procurements. *Journal of Business Research, 88*, 79–90.
Pulles Niels, J., Jasper, V., & Holger, S. (2014). Identifying innovative suppliers in business networks: An empirical study. *Industrial Marketing Management, 43*(3), 409–418.
Ragatz, G. L., Handfield, R. B., & Petersen, K. J. (2002). Benefits associated with supplier integration into new product development under conditions of technology uncertainty. *Journal of Business Research, 55*(5), 389–400.
Rothaermel Frank, T., & Tereza, A. M. (2009). Ambidexterity in technology sourcing: The moderating role of absorptive capacity. *Organization Science, 20*(4), 759–780.
Saputro, T. E., Gonçalo, F., & Bernardo, A.-L. (2022). A comprehensive framework and literature review of supplier selection under different purchasing strategies. *Computers & Industrial Engineering, 167*, Article 108010.
Schiele, H. (2010). Early supplier integration: The dual role of purchasing in new product development. *R & D Management, 40*(2), 138–153.
Schiele, H., Erwin, H., Markus, Z. B., & Justus, E. (2021). Why and how to involve purchasing in new product development? *International Journal of Innovation Management, 25*(3), Article 2150027.
Schiele, H., Stefan, K., Petra, H., & Rita, K. (2022). The "research world café" as method of scientific enquiry: Combining rigor with relevance and speed. *Journal of Business Research, 140*, 280–296.
Servajean-Hilst, R., & Calvi, R. (2018). Shades of the innovation-purchasing function—the missing link of open innovation. *International Journal of Innovation Management, 22*(1), Article 1850008.
Song, M., & Di Benedetto, C. A. (2008). Supplier's involvement and success of radical new product development in new ventures. *Journal of Operations Management, 26*(1), 1–22.
Spithoven, A., Bart, C., & Mirjam, K. (2011). Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation, 31*(1), 10–21.
Stek, K., & Holger, S. (2021). How to train supply managers–necessary and sufficient purchasing skills leading to success. *Journal of Purchasing and Supply Management, 27* (4), Article 100700.
Teece David, J., Gary, P., & Amy, S. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533.
Tu, Q., Vonderembse Mark, A., Ragu-Nathan, T. S., & Sharkey Thomas, W. (2006). Absorptive capacity: Enhancing the assimilation of time-based manufacturing practices. *Journal of Operations Management, 24*(5), 692–710.
van Echtelt, F., Wynstra, F., van Weele Arjan, J., & Duysters, G. (2008). Managing supplier involvement in new product development: A multiple-case study. *Journal of Product Innovation Management, 25*(2), 180–201.
Van Weele, A. J. (2010). Purchasing and supply chain management: Analysis, strategy, planning and practice. *Hamsphire: Cenage Leaning*.
Van Weele, A. J. (2014). *Purchasing and supply chain management, Sixth*. Hampshire, UK: Cengage Learning EMEA.
Villena Verónica, H., Elena, R., & Choi Thomas, Y. (2011). The dark side of buyer–supplier relationships: A social capital perspective. *Journal of Operations Management, 29*(6), 561–576.
Wagner, S. M. (2012). Tapping supplier innovation. *Journal of Supply Chain Management, 48*(2), 37–52.
Wynstra, F., Van, W. A., & Mathieu, W. (2001). Managing supplier involvement in product development:: Three critical issues. *European Management Journal, 19*(2), 157–167.
Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185–203.