

Research paper

Organizational Learning Practices to Develop Digitalization Capabilities in Circular Economy SMEs

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Abstract

The transition to the circular economy (CE) is widely driven by digitalization and data-driven innovation. However, whereas large companies typically have sufficient capabilities to fully exploit digitalization and data in their business and operations, small and medium-sized enterprises (SMEs) face challenges with the full utilization of digital technologies, coping with ever-increasing amounts of data and finding appropriate analysis methods. Therefore, SMEs operating in the CE sector have a clear need to develop their capabilities in implementing digital technologies to support CE business. This paper investigates how these companies can improve their dynamic capabilities in an inter-organizational learning process, where SMEs can transfer knowledge, make sense of it, and integrate it into their processes in joint action with other SMEs. The paper introduces a comparative multiple case study of six CE SMEs, all located in Finland, which have developed their dynamic capabilities by participating in collaborative learning activities with other SMEs facilitated by a university. The results reveal various learning practices for knowledge-sharing, joint sensemaking and knowledge implementation to support the development of dynamic capabilities for the digitalization of SMEs. The study also shows that inter-organizational learning not only helps the CE SMEs to improve their limited capabilities toward digitalization and data utilization, but also helps them to develop their own organizational culture in a direction that is more open to learning and absorbing new knowledge from outside the firm's boundaries

Keywords: Data Analytics · Dynamic Capabilities · Circular Economy · Small and Medium-Sized Enterprises · University-Industry Collaboration

1. INTRODUCTION

Digitalization and the efficient utilization of data can boost the transformation towards a more sustainable circular economy (Trevisan et al., 2023). It can help close material loops by providing accurate information on the availability, location, and condition of products (Antikainen et al., 2018). Digitalization has allowed CE companies to create new products and optimize existing ones in more sustainable ways, i.e. with less harmful effects on the environment (Hojnik et al., 2023; Yuan & Pan, 2023) utilizing various digital enablers such as the Internet of Things (IoT) or Industry 4.0 (Rosa et al., 2020). Lobo et al. (2022, p. 1) define the smart circular economy (SCE) as “an industrial system that uses digital technologies to provide intelligent functions for implementing value-added circular strategies.” It is nowadays uncommon for companies to make a transition to a circular economy without the adoption of digital tools, since these technologies greatly help them in many of their central operations (Trevisan et al., 2023), including resource optimization and increasing productivity (Kristoffersen et al., 2020).

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In the recent CE literature, there has been a strong focus on the role of eco-innovations and their environmental performance, whereas the influences, challenges, and opportunities of digitalization remain underexplored (Antikainen et al., 2018; Hojnik et al., 2023), and the convergence between the circular economy and digital technologies is still under-investigated (Bressanelli et al., 2022). Additionally, the number of commercial applications in companies remains limited (Okorie et al., 2018). Even though barriers to the CE transition have been extensively studied in various CE contexts (e.g., Ingemarsdotter et al., 2020; Kumar et al., 2021; Zhang et al., 2019), the barriers related to digital technologies in CE companies' business and operations have not received much attention in research. According to Isensee et al. (2020), the complex relationship between organizational culture, environmental sustainability, and digitalization has an impact on business development in smaller companies. In small and medium sized companies (SMEs), managers face similar challenges with digitalization and ever-increasing amounts of data, but they need to cope with these challenges with significantly smaller resources and capabilities than their counterparts in larger companies (Järvenpää et al., 2022). Barriers to adopting digital technologies are emphasized in SMEs for several reasons. First, SMEs are typically small organizations with limited resources and capabilities (Chaudhuri et al., 2022; Järvenpää et al., 2021). Second, the financial and operational resources of CE SMEs are also often more limited than their larger counterparts (Järvenpää et al., 2020). Third, whereas larger firms usually have sufficient capabilities to fully exploit digitalization and data, many SMEs lack the skills and resources to fully utilize the potential benefits of digital tools or to employ data-driven decision-making (Iqbal et al., 2018; Vimal et al., 2023). Indeed, whereas only a few previous studies have identified certain barriers to the effective adoption of digital technologies in CE companies operating in the SME sector, the empirical evidence of the practices related to overcoming these barriers remains underexplored. On the other hand, as organizational learning has been considered to be an efficient way for small companies to develop their capabilities and innovation performance (e.g., Fang et al., 2011; Hurley & Hult, 1998), participation in joint learning processes can be seen as a means for CE SMEs to acquire knowledge to develop their own skills and capabilities (Agyabeng-Mensah et al., 2021; Scipioni et al., 2021).

This article investigates how CE SMEs can develop the necessary capabilities for adopting and utilizing digital technologies in their business and operations in a learning process with other companies and expert organizations. The research question is: "How can organizational learning practices help CE SMEs to develop their capabilities and competences to adopt and utilize digital technologies?" Earlier research has revealed that the organizational practices related to the development of new capabilities and competences in CE organizations can be studied by using organizational learning theories (e.g., Agyabeng-Mensah et al., 2021; Scipioni et al., 2021). Thus, this paper aims to answer the research question by using the theories of organizational learning and dynamic capabilities as theoretical lenses to examine the building of digitalization capabilities in CE SMEs employing a qualitative case study.

2. DEVELOPING DYNAMIC CAPABILITIES IN CE SMES

Developing CE capabilities in firms has emerged as an effective response to environmental and sustainability pressures on them (Yuan & Pan, 2023). CE firms often operate in dynamic environments characterized by changing customer expectations, the rapid development of technology, unpredictable competition, and regulation, as well as complex supply chains and material flows. To be successful in developing and sustaining their competitiveness under these environmental circumstances, firms must develop their dynamic capabilities to integrate and reconfigure their resources to maintain sustainable competitive advantages (Warner & Wäger, 2019). The dynamic capabilities developed by firms enable them to draw on, extend, and redirect their technological capabilities and R&D resources (Helfat et al., 2007). Teece et al. (1997) define dynamic capabilities as: "The firms' processes that use resources—specifically resources to integrate, reconfigure, gain, and release resources—to match and even create market change." In the previous literature, the dynamic capability framework has taken a strong position in explaining how firms respond to rapid technological and market change (Eisenhardt & Martin, 2000; Helfat et al., 2007; Teece et al., 1997).

2.1 Dynamic Capabilities for Using Digital Technologies in CE SMEs

Dynamic capability theories can provide a framework for studying how firms can develop their capabilities and innovation performance in rapidly changing environments. Therefore, they can be used as a theoretical lens to

examine CE companies in their business environments. Applying the CE to the operations of firms can effectively utilize and integrate resources and incorporate environmental factors into their management. According to (Yuan & Pan, 2023), developing circular economy capabilities is one form of an expression of a dynamic ability to improve the environmental sustainability of companies. Additionally, Sehnem et al. (2022) found dynamic capabilities to be the most investigated research topic at the intersection of CE and innovation.

As suggested by Parida & Wincent (2019), digitalization and data-driven innovation are among the most essential factors driving the transition to CE. Data-driven innovation refers to a collection of processes employing tools and methodologies, such as data analytics, machine learning, and artificial intelligence, to generate fresh insights from existing datasets (Alghamdi & Agag, 2024). The role of dynamic capabilities has not only been found to be critical to a successful digital transformation in firms' business models, but also in making their business models more circular (Sandberg & Hultberg, 2021). The findings by Chaudhuri et al. (2022) show that CE companies have a clear need to develop adaptive capabilities when implementing digital technologies to support CE business, especially in the SME sector. Thus, CE companies typically have a high demand for digitalized, data-driven processes on both operational and strategic levels (Saleem et al., 2020), which may be a challenge for SMEs operating in the CE field (Isensee et al., 2020). Moreover, the exploratory utilization of data collected from the companies' operational and business processes, customers, and competitors can enable various data-driven approaches to different analysis, management, and decision-making functions (Chaudhuri et al., 2022).

2.2 Developing Dynamic Capabilities Through Organizational Learning

Organizational learning (Kuwada, 1998) has been widely conceptualized as a dynamic capability (Teece et al., 1997) and an antecedent of innovation (e.g., Fang et al., 2011; Hurley & Hult, 1998). Scholars have shown that CE firms may rely on organizational learning to acquire knowledge to drive the implementation of circular economy practices to achieve organizational sustainability and improve performance (Agyabeng-Mensah et al., 2021). SMEs typically operate with significantly narrower resources and capabilities, and therefore participating in organizational learning processes is particularly important (Scipioni et al., 2021). The concept of organizational learning can be divided into intra-organizational learning, where the learning process primarily takes place inside the firm, and inter-organizational learning, which relies on knowledge transfer from external sources and joint learning processes in collaborative relationships between stakeholders. Scholars have shown that inter-organizational learning (also known as relational learning (Selnes & Sallis, 2003) can improve firms' innovation capabilities and new product development (e.g., Lin et al., 2012). Thus, inter-organizational learning can be seen as a relational dynamic capability that can provide advantages for all the stakeholders involved in the collaboration (Huikkola et al., 2013; Kunttu & Neuvo, 2019; Perkmann et al., 2013). However, organizations vary in the ways they understand, make sense of, and utilize the same information. Therefore, sometimes the information acquired in joint action with other organizations is rejected; not because the information is unimportant to the organization, but because the organization cannot make sense of it or absorb it (Selnes & Sallis, 2003). Thus, firms that can acquire, assimilate, and exploit externally available knowledge have a better chance of achieving a high level of innovation performance (Lin et al., 2012). The theory of inter-organizational learning also suggests that successful implementation relies on two prerequisites: an open and sharing learning environment, and the absorptive capacity of learning entities. In this, mutual trust between partners is crucial (Kale et al., 2000). Successful implementation of inter-organizational learning fosters a shared understanding between members and enriches their knowledge bases (Allenbacher & Berg, 2023). The inter-organizational learning process originally suggested by (Selnes & Sallis, 2003), contains three phases, see Figure 1. In the first phase, knowledge-sharing, the partners share their previous knowledge and capabilities. In this phase, the partners do not only share formal and written documented information, but also their tacit knowledge that is often based on their previous experience. In the second phase, joint sensemaking, the partners work together to make sense of the knowledge brought into the collaborative process and build new knowledge on top of it in a shared process. The third phase, knowledge integration, is a process of making concrete outcomes from prior learning. The outcomes on the industrial side may be prototype implementations, demonstrations, or proofs-of-concept of the jointly developed technology.

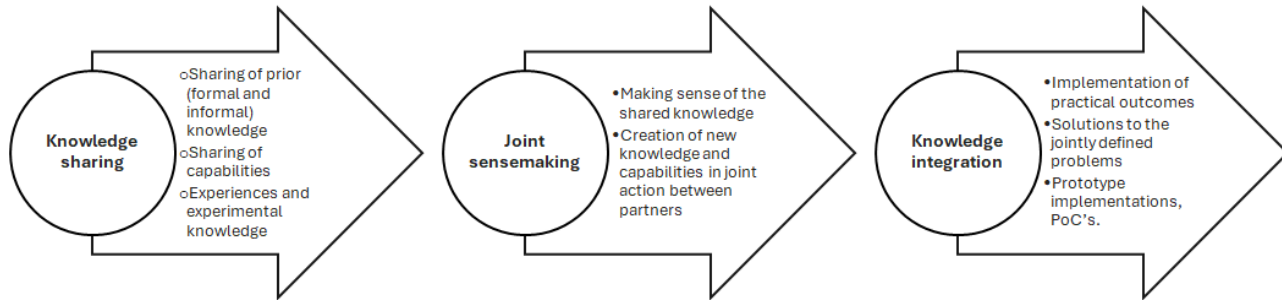


Fig. 1. Inter-Organizational Learning Process (Selnes & Sallis, 2003; Kunttu & Neuvo, 2019)

3. METHODOLOGY

The empirical part of this paper presents a comparative multiple case study of six Finnish CE SMEs. The relationship learning process is studied in each case by investigating the development of data-driven dynamic capabilities in CE SMEs by using the framework that relies on the three phases of inter-organizational learning process (Selnes & Sallis, 2023; Kunttu & Neuvo, 2019) as described in Section 2. The main research interest in the first phase of the process (knowledge sharing) is to understand the practices of knowledge sharing in the interaction between the collaboration partners, also including the sharing of tacit knowledge and experiences. In the second phase (joint sensemaking), the goal is to investigate the practices of the partners' joint action in building new knowledge on top of the previous knowledge that they both bring to the collaborative process. Finally, in the third phase (knowledge integration) the research focuses on the implementation of the results of the joint knowledge creation process. In this phase, the researchers investigated the practices and processes related to building the outcomes of the collaborative process. The case companies summarized in Table 1 provide waste management services, biogas production, recycling, and consulting. These companies represent business areas that are quite typical in the CE sector in Finland, and therefore they are representative examples of the CE transition since the utilization of data and digital technologies provide many development opportunities for these areas. The companies have participated in a long-term series of interactive learning and development projects (between 2020 and 2024) that have been facilitated by a local university (Häme University of Applied Sciences, HAMK). The focus of the development projects has been on developing the firms' capabilities in digitalization and data analysis by means of co-creation, co-development, and joint learning. The firms have been engaged in learning workshops in which they have shared their own experiences, knowledge, and skills with other companies, and jointly recognized ways to improve their capabilities in digitalization and data analysis. The university has facilitated the learning workshops and shared its capabilities with the companies. The university has also provided the companies with student groups, which have carried out practically oriented projects for the companies.

This paper studies how these CE companies have been able to gain their dynamic capabilities in digitalization and data analytics in joint learning activities with other CE companies in a close collaborative relationship with a university. There were three main methods for this collaboration. The first were workshops between companies, where the companies were gathered to consider some key topical area of digitalization and data utilization in CE. These workshops were facilitated by university researchers. The second method was learning from company cases, where the university researchers and company representatives worked on a specifically defined development task suggested by one of the companies. The third method involved student projects, where student groups supervised by university researchers worked on a development topic suggested by one or several companies. The purpose of the student project work was to transfer fresh insights and new experimental knowledge to the companies. Table 2 presents a summary of the three main methods of collaboration.

The empirical data was collected from the case companies in five interview rounds in 2020, 2021, 2022, 2023, and 2024. A semi-structured interview template following the three phases of the inter-organizational learning framework was used. To ensure the reliability of the study, the researchers applied a data triangulation technique

(Beverland & Lindgreen, 2010) that involved additional data collected from the student projects including course reports, presentations, and other outcomes created by the students and company representatives. Because the interview data reflected the interviewees' own views on collaboration practices and history, they were interpretative in nature, and accordingly the researchers paid attention to monitoring and discussing these issues during the data collection process by comparing the answers of other stakeholders of the case, and asking additional questions (Brennan & Turnbull, 1999). The researchers also cross-checked each other's independent interpretations (Eisenhardt 1989). The analysis process was also iterative, since the researchers were able to reflect the preliminary analysis results from previous interview rounds on the following rounds. In addition, in the final interview round, open questions were posed to validate the conclusions and quoted material related to the central themes emerging from the interview data.

Table 1. Descriptions of the Case Companies Participating in the Collaboration with the University

	Case A	Case B	Case C	Case D	Case E	Case F
Number of employees	100	50	90	<5	<5	5-10
Main products/services of the customer company	Waste management and recycling services	Waste management, recycling services and solutions, biogas production	Waste management and recycling services	Other management consulting	Producer responsibility organization	Producer responsibility organization
Participation in joint development facilitated by the university	2020-2024	2020-2024	2021-2024	2022-2024	2022-2024	2022-2024
Company interviewee	CEO	CEO	Chief Development Officer	CEO	Managing Director	Chief Operating Officer

Table 2. Three Main Methods of Collaboration Studied in This Paper

	Learning approach	Company representatives' role	University role
Workshops between companies	Joint learning and co-creation in thematic workshops arranged by the university.	The company representatives share their experimental knowledge and best practices developed in the companies.	University researchers facilitate the learning process by presenting viewpoints and their research-based knowledge on the topic being learned.
Learning in company cases	Key stakeholders from the companies and the university work together to find solutions to a specific development challenge.	The company representatives share their experimental knowledge and best practices developed in the companies to find solutions to a problem.	University researchers facilitate the learning process by presenting viewpoints and their research-based knowledge on the topic being learned.
Student projects and trainees in companies	Student groups supervised by university researchers find solutions to a development topic suggested by one or several companies.	The company provides a topic and supervisor for the topic.	University researchers supervise the student groups.

4. RESULTS

In this section, the interview data is analyzed from the viewpoint of the three phases of relationship learning: knowledge-sharing, joint sensemaking, and knowledge integration.

4.1. Knowledge sharing

The process of knowledge-sharing or knowledge transfer is broadly defined as an activity aimed at transferring knowledge or technology that either party can use to further pursue their activities (Arvanitis et al., 2008). Tsai (2001, p. 996) has suggested that “knowledge transfer among organizational units provides opportunities for mutual learning and inter-unit cooperation that stimulate the creation of new knowledge and, at the same time, contribute to organizational units’ ability to innovate.” Thus, a significant volume of literature focusing on organizational knowledge flows regards knowledge accessibility as a driver of innovation (e.g., Easterby-Smith et al., 2008; Maurer et al., 2011). This literature suggests that whereas critical knowledge for firms is normally developed within a firm, it is also increasingly important that they possess the ability to learn from others to meet the increasing pace of competition. The data collected in the interviews supported this, and especially highlighted the role of the workshops organized to support the knowledge-sharing between companies, as illustrated in the quotations from the cases below:

“The R&D resources of small companies, like us, are quite thin and we cannot invest much. Through this kind of cooperation, we are able to gain fresh insights; these are great opportunities for us that should be taken advantage of.” Case A

“Information has been exchanged through discussion. We have learned to perceive the needs and perspectives of other actors and how to take them into account in our own operations. Similar solutions can be found in different industries.” Case B.

When asked about the factors that enable and facilitate efficient knowledge transfer in the relational learning process between the companies, the interviewees underlined the importance of involving the right people from the companies in the interaction, as explained below:

“Efficient interaction requires the participation of the right people: a person of the right level. Not everyone who knows about things necessarily has decision-making power or may not dare to say anything because there is no mandate. If the wrong person is involved, it may not lead to anything.” Case D

Previous research has shown that balancing the confidentiality of business sensitive data can be a challenge in collaboration where companies interact with each other or with research institutes (Kunttu & Neuvo, 2019). However, based on the interview data, confidentiality was not a major issue in the interaction between the companies, as the following examples show:

“We can learn from the other firms’ experiences. There was an open discussion and information sharing.” Case F

“The confidentiality of information caused challenges to some extent, but we limited information so that confidentiality did not become an issue.” Case B

A relatively open attitude toward sharing business-sensitive topics in the workshops and other interactions indicated that even though the firms are operating partly in the same business areas, they consider learning and capability development more important than protecting their own business. The interviewees also mentioned that during the long-term interaction, mutual trust between the companies was developed through personal links and familiarity. The same applies also to relational capital (Kale et al., 2000), which refers to the level of mutual trust, respect, and friendship that arises in close interactions at the individual level within close interaction between companies.

4.2. Joint sensemaking

In the second phase of the relationship learning, joint sensemaking, stakeholders (companies) jointly make sense and improve their understanding of the problem to be studied and find explanations and solutions (Selnes & Sallis, 2003). In the process of joint sensemaking, the partners need to align their expectations as well as combine their skills, knowledge, and capabilities to solve a problem (Kuwada, 1998). As the knowledge and experience of the collaboration partners may be very different (Estrada et al., 2016), the parties need to make efforts to combine their knowledge and jointly develop new experimental knowledge. The interviewees reported that they were able to utilize the advice given by other companies in the workshop, for example in the form of new tools:

“Brainstorming workshops with other companies and the university can open up many kinds of new ideas. For example, our new inventory tracking tool has been implemented based on this kind of collaboration and a student’s thesis project.” Case A

“We have learned from the examples of other companies. One good example is logistics optimization, where our needs are similar to other companies. This collaboration has sparked ideas for our own activities: how we would be able to take advantage of each other’s companies and offer services across companies. In addition, based on what was learned in the project, we made a calculator that can be used to assess the profitability of route planning.” Case B

The interviewees also highlighted the role of the facilitator (the university), which brought the company representatives together and stimulated the discussion:

“Bringing the stakeholders together is really necessary, but at the same time the biggest challenge is to be able to produce added value. The facilitator’s role is to identify opportunities for cooperation between actors.” Case D

“Well facilitated workshops and discussion sessions have opened up new perspectives for our business opportunities.” Case C

The interviewees emphasized the interaction and discussions with relevant stakeholder groups, such as consumers and service end users:

“In data-related development, it is important to have a conversation with stakeholders so that they can influence what the platform will be like and how information is entered there.” Case D

As part of the interactive workshops with companies, the university also involved student groups in this collaboration. The idea was to give the student groups a project topic that came from the companies’ development needs identified in the company workshops. One of the most essential topics selected was the use of data analytics tools and technologies, in which the student groups were instructed to support companies. The interviews indicated that the companies gained knowledge and understanding of their own company-specific data through the analysis tasks carried out by the students. In this process, the companies also got concrete development ideas. In the words of the case company representatives:

“The students asked questions that we hadn’t even been able to think of before.” Case C

“At the point when the first visualizations were shown, I was amazed at what the students got out of the data.” Case D

This is in line with earlier research on the facilitating role of students and graduates as boundary actors between the educational system and companies (Kunttu, 2017; Kunttu et al., 2018), suggesting that these actors do not only transfer knowledge to companies, but they also help them to improve their absorptive capacity and learning skills. Based on the experiences obtained in the first student projects, the sensemaking carried out with the companies was formalized as a list of questions that were asked from the case company representatives regularly during the project. The purpose of these questions was to guide the interaction and sensemaking process in the joint learning between the students and the company, as illustrated in Figure 2. The company representatives described their experiences of the joint sensemaking facilitated by the student projects in the following ways:

“The students ask questions and offer perspectives that we haven’t noticed.” Case A

“The students provided us with new competences, an outside vision, and fresh thinking.” Case B

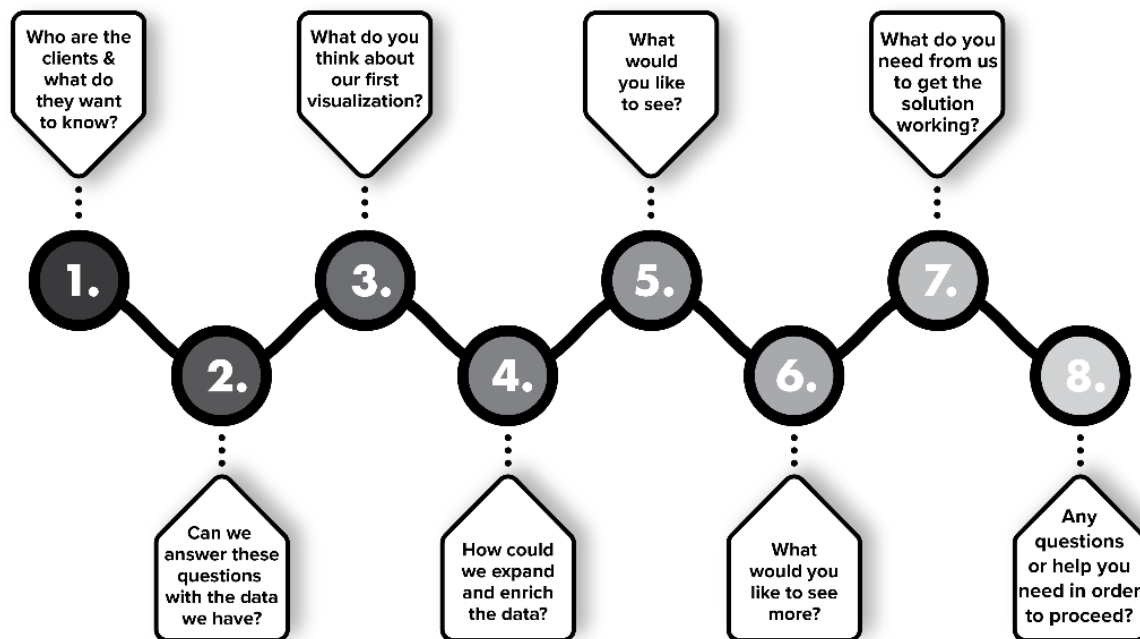


Fig. 2. Joint Sensemaking Process in Data Analytics Projects

4.3. Knowledge integration

The knowledge integration process is also often seen as knowledge implementation, where the partners involved in the learning process find ways to utilize the jointly created knowledge by implementing it into new technologies, services, or processes, for instance (Williams & McGuire, 2010). In many companies the aim is to typically implement the outcomes of the joint learning process into prototypes to be tested and evaluated, and then commercialized as final products (Chen et al., 2010). When the interviewed company representatives were asked about the results and outcomes of the joint learning activities in their companies, almost all mentioned first the increased awareness and understanding of technological development, particularly in digitalization:

“We have gained an understanding of the quality of data and what the factors to consider are when collecting data. We have also gained insights into how to utilize data.” Case B

“Interaction with other companies, university researchers, and student groups is eye-opening for us. Without this kind of interaction, we would go with our eyes in one direction and would not see the big picture in the development.” Case E

In this manner, the interactive collaboration with other companies did not only provide the companies with dynamic capabilities in digitalization and data analysis, but it also developed their absorptive capacity to gain new knowledge. The companies also reported on the outcomes of their development in digitalization and data analytics capabilities during the interaction with other companies:

“As a result of this collaboration and with the help of the student groups we started to use a new digital application that clearly improves our capacity planning.” Case A

“There are constantly new insights from following the other companies’ ways of working and how they use information. Also, the data processing capabilities of the student groups creates a basis for increasing our knowledge and understanding.” Case D

Most of the interviewees emphasized the role of the student groups as key actors in terms of knowledge implementation in the companies. According to the company representatives, the outcomes achieved in the learning process helped them to increase their understanding of their business, generated new ideas, and familiarized the companies with new data analytics tools:

“The data analysis and visualization tools introduced by the students have now been incorporated as part of our reporting; we can monitor the flow of materials as well as the balance of the process.” Case B

“We have learned that between the mathematical model and our real-life problem, it is still good to have a transport expert who translates it (the problem to be solved) between the two worlds to be interpreted.” Case C

The companies were also able to utilize the work outcomes of the student teams by implementing them in e.g. reporting and operations planning. Consequently, the interview data reveals that the students did not simply engage in knowledge transfer, but they can act as knowledge implementers in the firms:

“Data exploitation could be a topic for a new project. The students have also been active in proposing this kind of task in the company.” Case A

“The current solution will be complemented by further development to create predictive models.” Case B

This finding is well in line with earlier research (Kunttu, 2017; Kunttu et al., 2018) indicating the important role of students and university graduates as boundary spanners and knowledge brokers between universities and industry (Siegel et al., 2004). This highlights the challenge of knowledge implementation in instances where the company does not have staff familiar with digitalization or data analytics solutions and prior experience of carrying out data analytics themselves.

5. DISCUSSION

Even though recent studies have shown the positive influence of digital technologies in the CE sector, and that the efficient utilization of those technologies is a crucial capability for all the companies operating in CE, the barriers to the transition to a smart circular economy are particularly high for SMEs. Whereas large companies typically have sufficient capabilities to fully exploit digitalization and data in their business and operations, many SMEs have very limited resources for deploying digital tools or employing data-driven decision-making in their business (Chaudhuri et al., 2022; Iqbal et al., 2018; Järvenpää et al., 2021; Vimal et al., 2023). Thus, CE SMEs face challenges with the full utilization of digital technologies, coping with ever-increasing amounts of business and process-based data and finding appropriate analysis methods to make sense of it. This is related to the well-known limitation of the SME sector of having limited data analysis capabilities. The analysis in this paper is based on the three phases of relationship learning: knowledge-sharing, joint sensemaking, and knowledge integration. Table 3 summarizes the outcomes of the empirical work presented in this paper. It summarizes the practices that were found to facilitate learning and new knowledge development in these three phases. Thus, this study contributes to the existing research on digital transition and capability development in CE companies with a special focus on SMEs.

This paper investigated how CE SMEs can develop their dynamic capabilities in digitalization and data analysis by means of organizational learning in close collaboration with other companies. This study also improved the understanding of how the joint learning process can help companies gain capabilities and develop their learning capabilities to generate their competitive advantage. As concluded by Isensee et al. (2020), organizational culture, environmental sustainability, and digitalization have an impact on the business development of SMEs. Our study reveals that all three of these themes are involved when the CE SMEs participate in the joint learning process, share their practices, experiences, and knowledge with their counterparts, jointly make sense of the new challenges and their potential solutions, and build their own company-specific solutions that are based on the newly learned knowledge (Lin et al., 2012). All this requires mutual trust between the companies, especially when many of them are competing against each other, at least in some business areas. On the other hand, the results obtained in this study reveal that in a good and fruitful collaborative atmosphere, partners gradually learn to create new knowledge together in such a manner that everyone benefits from it. This, in turn, builds mutual trust and relational capital between the partners through personal links and familiarity (Kale et al., 2000), and thus fosters new interaction in the joint learning activities. These findings are well in line with previous, rather limited research on the opportunities of relational learning in developing the dynamic capabilities of CE companies (Agyabeng-Mensah, 2021; Scipioni, 2021), but they also suggest that relational learning requires organization and facilitation in a systematic manner, which in turn require long-term commitment from all the stakeholders participating in the learning process (Lewicki et al., 2006). As concluded by (Allenbacher & Berg, 2023), successful implementation of inter-organizational learning fosters shared understanding among members and enriches their knowledge bases.

6. CONCLUSION

In conclusion, the results of the qualitative research conducted in this paper reveal that a joint learning process aiming at better adoption of digital technologies and data analytics does not only help small CE companies to improve their limited capabilities in these areas, but also helps them develop their own organizational culture in a direction that is more open to learning and absorbing new knowledge from outside the firm's boundaries. In this manner, by engaging in learning activities with external partners, companies not only improve their dynamic capabilities in data and digitalization, but they also develop their absorptive capacity, which in turn has a positive impact on innovation performance and competitive advantage.

6.1. Practical implications

As a practical implication, applying inter-organizational learning to interaction between companies provides them with a straightforward method to gain capabilities in areas relevant to the whole industrial sector. Especially for SMEs with limited resources and learning capabilities, learning from others' experiences and knowledge can be a very helpful way of improving their own capabilities and creating networks for further learning. Moreover, the results of this study also indicate that the interaction with other companies contributes not only to the technical or business-based capabilities of the companies, but also to their abilities to learn and absorb new knowledge from the outside world. The study also highlights the students' role as potential knowledge brokers between educational and

research institutes and industry. They not only bring new knowledge to the companies but also help implement the outcomes of the learning process.

6.2. Limitations and future directions

This qualitative study focused on six Finnish circular economy companies, and therefore the data used to draw the conclusions was somewhat limited. For this reason, additional studies—both qualitative and quantitative—could help to generalize the outcomes presented in this paper. In addition, this study was conducted in the context of Northern Europe (Finland), where CE processes are quite widely accepted, and digital tools and technologies are widely employed. Studying how organizational learning could help to overcome barriers to the adoption of digital technologies in CE in other cultural areas would be an interesting direction of research in the future. In addition, exploring the drivers that led these practices to be successful in the current cases would be an interesting area of further research by completing the qualitative analysis with quantitative evidence. In the same manner, the role of the university as a facilitator of the learning process and as an accelerator of sustainability on a local level could be further studied.

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AUTHOR CONTRIBUTIONS

Anne-Mari Järvenpää: Literature review, empirical data collection and analysis

Jari Jussila: Literature review, Framework development, empirical data collection and analysis, conclusions

Leena Kunttu: Framework development, discussion and conclusions

Iivari Kunttu: Literature review, Methodology. Framework development, discussion and conclusions

DECLARATIONS

Competing interests The authors declare no competing interests.

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